Computer Problems: Sorting Out What's To Blame

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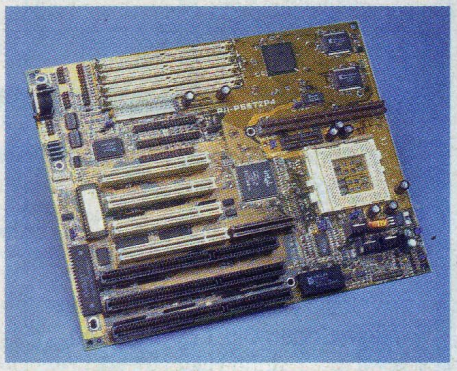

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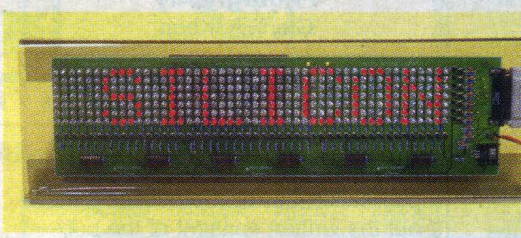

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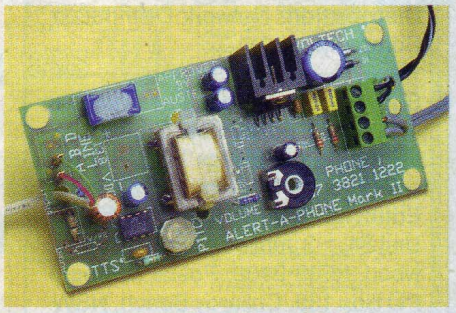

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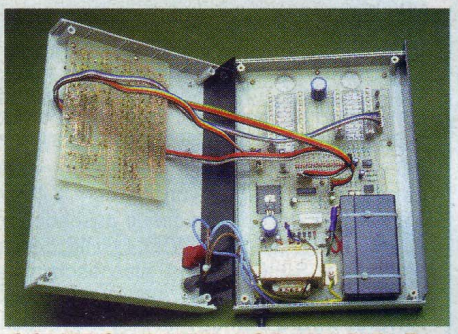

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PUBLISHER'S LETTER

Tariff reductions on cars may not be wise

As this issue goes on sale, we can expect that the Government will be placed under intense pressure to speed up tariff reduction in the car industry. Just before Christmas, the Productivity Commission brought down a majority report that urged tariff reduction from 15% in 2000 to just 5% in 2004. Presently, tariffs on imported cars are at a level of 25% and to reduce them to 5% in less than 10 years is a huge reduction in anyone's language.

Many economists would argue that Australia should proceed down the path of tariff reduction for all economic activities and in terms of hard financial figures, they are undoubtedly right. When tariffs are removed or reduced, the products affected invariably are reduced in price and consumers are better off. But will we be better off overall?

We have already seen this happen with electronics consumer products and there is no doubt that they are much cheaper now than they would have been if tariffs had been maintained. The problem is that while all those goods are undoubtedly cheaper, we have also lost a great number of skills that went with the manufacturing and servicing of those electronic products. Not only the skills but most of the jobs have been lost and in many cases the people directly affected have never got equivalent satisfying employment again, if they have managed to get jobs at all.

The same thing will happen as tariffs are reduced on cars. New cars and secondhand cars will become cheaper. But then we will lose many thousands of jobs in manufacturing, not only in the car industry itself but in all of the support industries, and that includes some electronics manufacturing, surprising though it might seem. But it will go much further than that. If new cars are cheaper, then it will become uneconomic to repair cars. So we will inevitably lose huge numbers of jobs in repair shops – not only mechanical repairs but in smash repair shops as well. Many more cars will simply be written off and sent to the crushers after even quite minor accidents.

It is fairly safe to say that most of the people working now in the car manufacturing and repair industries would never get equivalent jobs again. And youth unemployment which is unacceptably high now, will go even higher.

No, while we would all like to buy cheaper cars and enjoy the safety and driving pleasure that a new car entails, we will be paying a huge social price if we go down that road too rapidly. Sure, we are paying a high price to effectively subsidise a lot of jobs in the car industry. But people and the general community are always better off if they are gainfully employed instead of being on the dole.

Let us hope that the history of the Australian electronics consumer industry is not repeated in the car industry.

Leo Simpson

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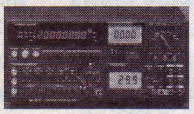

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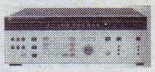

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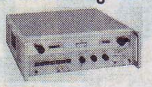

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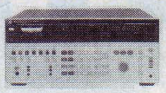

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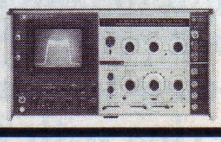

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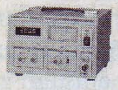

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Sorting out what's really to blame

If there's one thing I've learnt about computers over the years, it's not to jump to conclusions when something doesn't work properly. When things go wrong, it's all too easy to blame the obvious, without getting to grips with what's really at fault.

By GREG SWAIN

How often have you heard that a particular operating system is unstable? Or that it doesn't work on such and such a computer? Or that a particular item of hardware has a "bug" and should be avoided? Or that something just doesn't work when your own experience indicates otherwise?

When it comes to computers, there are enough real problems to sort out without having to also sift through a mine of misinformation, straight-out bad mouthing and old wives' tales. I'd like a dollar for every time that someone has rolled their eyes to the ceiling when told that SILICON CHIP is produced using PCs, for example.

I mean, *everyone* knows that Macs are the all the go when it comes to desktop publishing, don't they? I've even been told that PCs are no good in this role because "they just don't work" and because "they have font problems".

Well, you could have fooled me. There we've been all those years, successfully producing a magazine using PCs that don't really work – at least according to the hearsay of several self-appointed experts.

What rubbish! We've used PCs in the desktop publishing role for over six years now with very few problems but try telling that to some people. Not that it's ever really worth the bother – a few pointed questions invariably reveal that such people know very little about PCs, and are simply basing their opinions on "common knowledge".

"A computer is really a box full of gremlins, just waiting to wreak all sorts of havoc at the user's expense".

It's all the stuff of myths and legends but if it's "common knowledge", then it must be true. I'm not seeking to belittle Macs here, by the way. I'm simply making the point that the PC is a valid alternative for desktop publishing, despite what many ill-informed people will try to tell you.

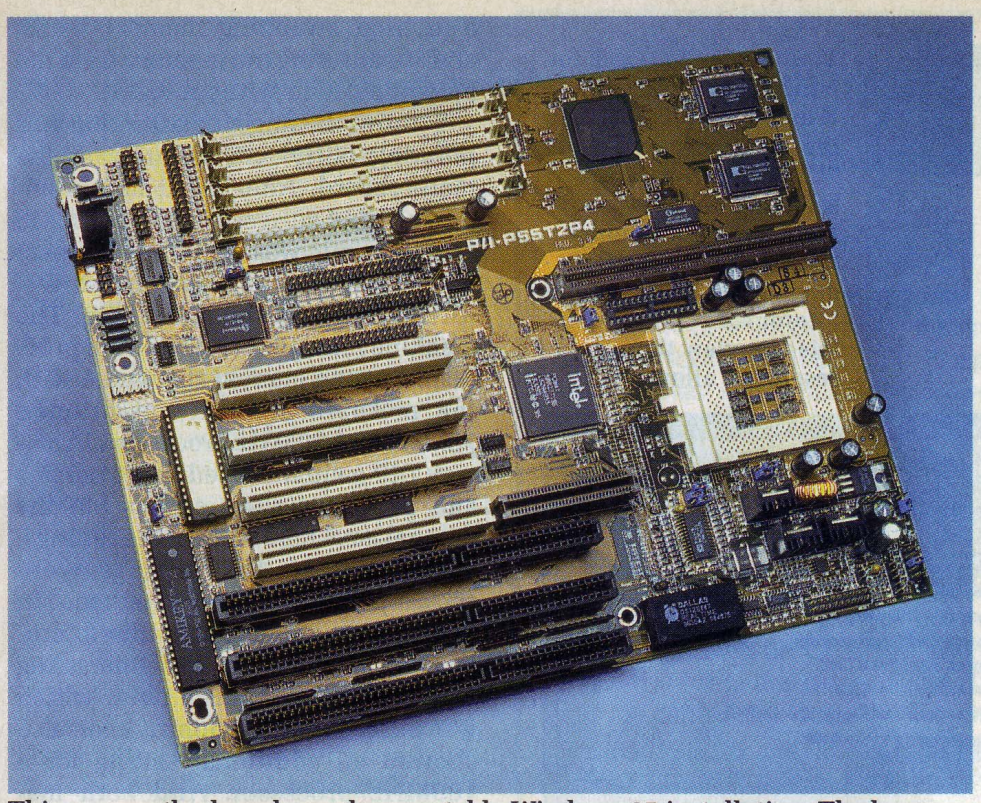
The most common misconceptions by far arise out of hardware and software upgrades. The reasons are not too hard to find. Hardware upgrades, in particular, are often not straightforward for a variety of reasons. After several recent experiences of my own, I'm convinced that a computer is really a box full of gremlins just waiting to wreak all sorts of havoc at the poor user's expense.

OK, so I'm exaggerating somewhat but if you've ever attempted to add hardware to a PC, you'll know what I mean. Even Windows 95's much vaunted Plug and Play (PnP) system has problems in some circumstances. Let me give you a couple of examples of what can happen when even relatively simple upgrades are attempted.

The not-so-crook RAM

Recently, we decided to upgrade the RAM in a couple of our office machines from 32Mb to 64Mb. These two machines used identical motherboards and in each case, the existing RAM consisted of two 16Mb SIMMs. As a result, we decided to purchase two new 32Mb SIMMs for the first machine and transfer its existing 16Mb SIMMs to the second machine.

Installing the new 32Mb SIMMs was straightforward enough but when we



This new motherboard cured an unstable Windows 95 installation. The bus speed of the motherboard in the original machine had apparently been pushed beyond its design limitations – or, at least, that's one theory.

switched on, the machine refused to boot. Sometimes it would just hang after completing the BIOS checks. At other times, it would start to boot the operating system and then halt, with a screen full of obscure error messages.

Our first thought was that we must have dislodged a cable when installing the new RAM but a quick check revealed that all was as it should be. Our next snap diagnosis was crook RAM and this was seemingly confirmed when it also failed to work in the second machine. Yet when we substituted the old RAM, both machines booted without problems.

That was it, of course – one of those new 32Mb SIMMs just had to be faulty!

But was it? Perhaps the problem was in the two machines which, after all, were virtually identical. The only way to find out was to try the new SIMMs in a third machine with a completely different motherboard. When we did, it booted straight up and performed flawlessly.

So much for our snap diagnosis of faulty RAM! Instead, it appears that the motherboards in the first two machines weren't happy with the 60ns RAM on the new SIMMs (the older SIMMs used 70ns RAM). And there were no settings in the system BIOS that could compensate for this.

We solved the problem by leaving the new SIMMs in the third machine and sharing its original four 16Mb 70ns SIMMs between the first two machines. So all three machines ended up with 64Mb of RAM – it's just that the two new 32Mb SIMMs ended up in an unexpected location.

But it's easy to see how misunderstandings can arise in this sort of situation. We could have easily been fooled into returning perfectly good RAM to the supplier, demanding that it be replaced. And of course, the replacement RAM would have caused exactly the same problems.

Operating system myths

There are also plenty of myths floating around regarding operating systems. One that I've heard from a couple of people is that Windows 95 needs a Pentium processor and won't run on a 486. Wrong! What they really mean is that they couldn't get it to work on their particular 486 for some reason or other.

To prove the point, we recently installed the Win95 upgrade pack on an old 50MHz 486 machine. It ran without a hitch and I've even heard of people running Win95 on a 386.

Hardware conflicts are often the root cause of aborted operating system upgrades. Win95 cannot automatically assign interrupts (IRQs) to non-PnP expansion cards (now referred to as "legacy" cards) and can easily get itself into a knot if left to its own devices.

To explain, a standard PC has 16 interrupts (0-15) available but most of these are taken by the system, leaving about six free for expansion cards (depending on the configuration). Each expansion card must be assigned a unique IRQ; if two cards have the same IRQ, there will be a conflict and the system won't work properly.

The "minimalist" approach usually works well when installing Win95, particularly if you have a mixture of legacy and PnP cards. This involves removing all non-essential cards, such as sound cards and network cards, before installing the software. Once the system is up and running properly, you can add the expansion cards back in, one at a time.

By the way, it's best to add the legacy cards first, as the PnP cards are automatically assigned the leftover IRQs. In addition, the system assigns IRQs to PnP cards in ISA slots before those in PCI slots.

Note also that you should reserve the appropriate IRQs for the legacy cards in the system BIOS, where this facility exists (ie, if the motherboard has a PnP BIOS). This will usually be found under a "Plug and Play Configuration" (or similar) menu. For example, if you have a legacy card that's set to IRQ10, then you must assign IRQ10 for use by an ISA card.

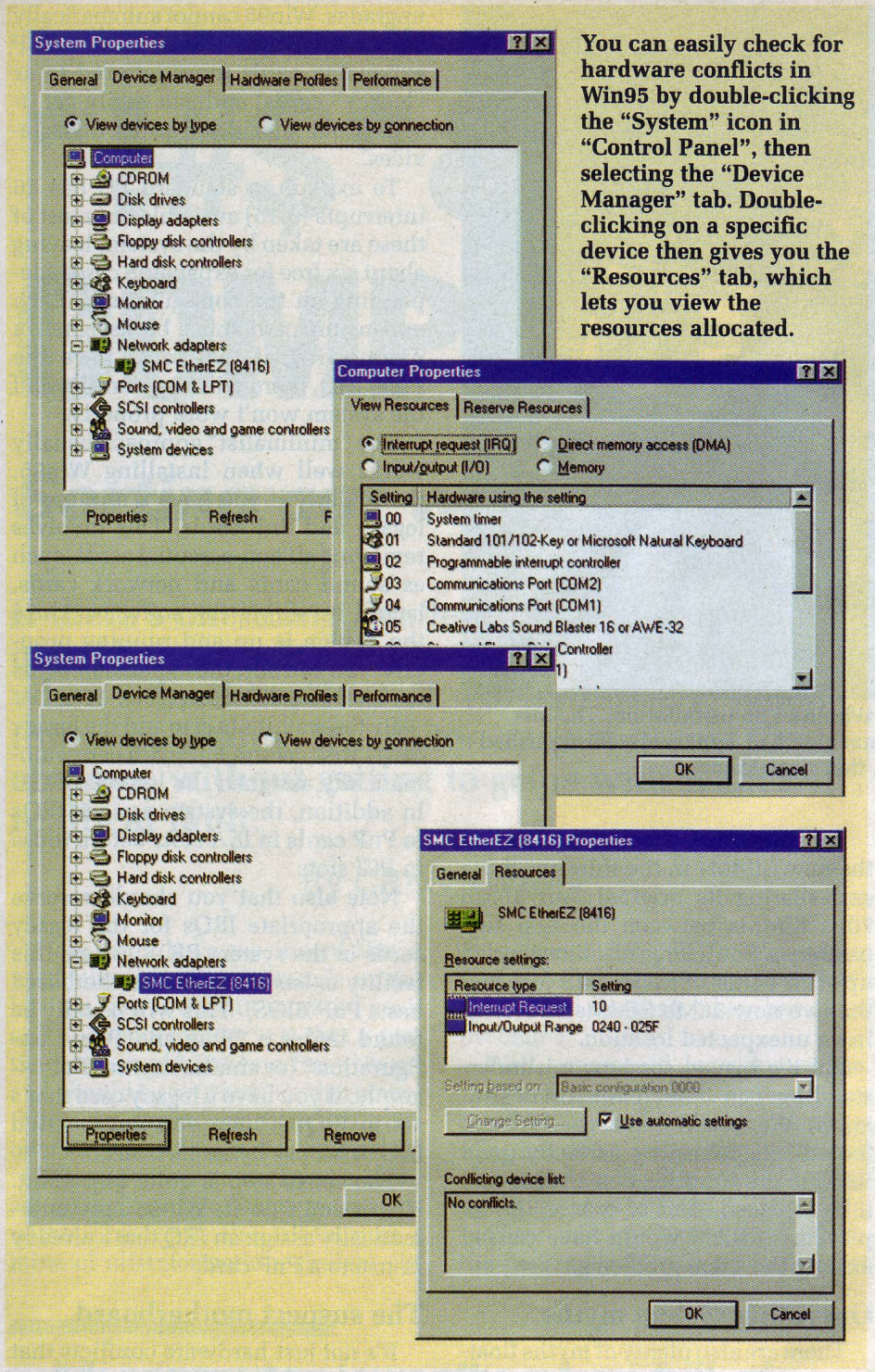
The above step is quite important. If you don't do it, Win95 may automatically assign an IRQ that's already in use to a PnP card.

The suspect motherboard

It's not just hardware conflicts that can be a problem. Hardware bugs can also cause problems and lead to unfair criticism of an operating system or even individual programs.

Consider my own experiences with Windows 95 which is installed on my main office machine. This is one of the machines described above that didn't like the 60ns 32Mb SIMMs and the problem I am about to describe is directly related to the memory upgrade.

As mentioned earlier, this machine was originally configured with 32Mb of RAM (2 x 16Mb SIMMs). It is set up



You can easily check for hardware conflicts in Win95 by double-clicking the "System" icon in "Control Panel", then selecting the "Device Manager" tab. Double-clicking on a specific device then gives you the "Resources" tab, which lets you view the resources allocated.

as a dual-boot Windows 3.11/Win95 system but I was never entirely happy with the system under Windows 95 as it occasionally crashed when the going got heavy.

My first inclination was to blame which ever program I happened to have running at the time but eventually I began to suspect Windows 95 itself. However, the pattern was too intermittent to really get to grips with the problem.

The breakthrough came when the extra 32Mb of RAM was added. Windows 3.11 continued to work normally but not so Windows 95. It now frequently crashed, generating "Unexpected Exception" errors in the process. And when it crashed, it would often refuse to boot again unless the additional RAM was removed.

This meant that the problem was probably hardware related. Initially, I simply tried replacing the original RAM with the second two 16Mb SIMMs but this made no difference. I also tried swapping memory banks and substituting the memory from the machine's twin without result.

By now, the finger of suspicion was pointing fairly and squarely at the motherboard. After all, it had previously failed to work with the 32Mb SIMMs, so it was definitely suspect when it came to handling memory.

And there was another thing. The machine ran a 133MHz Pentium processor but the manual that came with the motherboard only mentioned 75MHz and 90MHz processors. An 8-way DIP switch is used to set the bus and processor clock speeds but the manual gave no details of the settings.

Fortunately, the settings were screen-printed on the motherboard in a vacant area adjacent to the microprocessor. But what was interesting was that the machine's twin, which was purchased four months later, also showed an additional setting for a 100MHz processor. And both machines were set to this configuration.

That aside, the motherboard was obviously originally designed to operate at a bus speed of either 60MHz when used with a 90MHz processor, or 50MHz when used with a 75MHz (or 100MHz) processor. That's because the processor always runs at some ratio of the bus frequency, the available ratios in this case being 1.5x and 2x (ie, 1.5 x 50MHz = 75MHz, 1.5 x 60 = 90MHz, and 2 x 50MHz = 100MHz).

So what was going on? A 133MHz processor requires a 66MHz bus so the board must have been tweaked to run at this higher speed – probably by the simple expedient of substituting a different crystal in the clock circuit during manufacture. Fairly obviously, this was an existing design that had been hastily adapted to cater for the faster processor but it appeared that it wasn't up to the task – at least not with Windows 95.

There was nothing for it but to change the board.

It ain't that easy

Now if you thought that changing the motherboard in a Win95 system was a straightforward task, think again. The mechanical installation is easy enough but getting everything up and running again is a different matter. Windows 3.11 was OK (it's too dumb to recognise the swap) but Windows 95 is too clever by halves, tying itself in all sorts of knots when it discov-

ered the new motherboard.

This problem apparently stems from the fact that the parameters of the new motherboard and its BIOS don't match the existing registry settings. In the end, the only way around the problem was to clean off the existing installation and its associated applications and reinstall all software.

If you're ever in this situation, by the way, don't be tempted to simply reinstall the operating system over the top of the existing installation. It's best to clean everything off and go for a fresh installation.

The Win95 reinstallation was not without a small glitch, however. I'd removed the sound card but left in a SCSI card and a PnP network card. Everything went fine until the first boot. Windows 95 made it past the logon dialogs but then announced that it was searching for new hardware. There followed a brief period of hard disc activity, after which it just "hung".

I tried switching the machine on and off several times but always with the same result. Eventually, I pulled the network card and tried again. And that was it – the system now booted correctly and I was able to reintroduce the sound and network cards.

Windows 95 now recognised the network card, installed the correct driver for it and automatically assigned an available IRQ. Now why didn't it do that in the first place?

Did the new motherboard do the trick? Well, based on my limited observations so far, the answer is yes. I now have a stable Windows 95 installation but just think how easy it would have been to jump to conclusions and bad-mouth the operating system.

Strangely enough, the other machine with the identical motherboard operates perfectly with its 64Mb of RAM but then it's running Windows NT. So is Windows 95 fussier than NT about the hardware company it keeps? Or was it just a matter of manufacturing tolerances between the two boards? Or was the problem caused by some subtle hardware conflict which is now resolved and nothing to do with the motherboard at all?

Finally, could I have cured the problem by changing the DIP switches so that the motherboard ran at a slower bus speed (yes, this would have throttled back the processor)?

We'll probably never know the answers to those questions. **SC**

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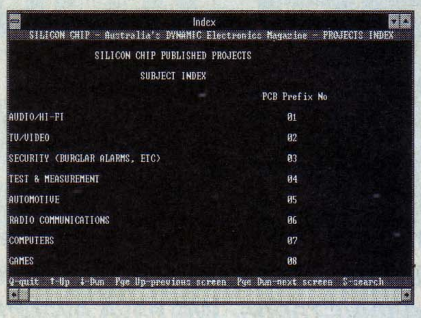
SILICON CHIP SOFTWARE



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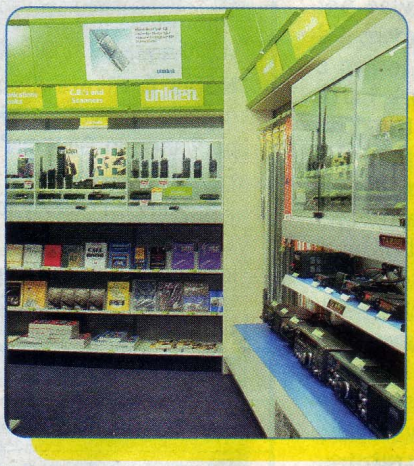

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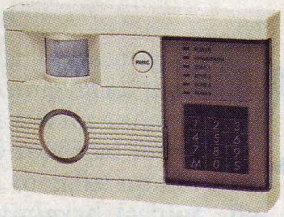

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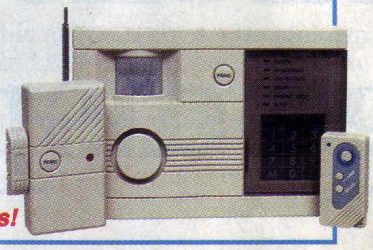

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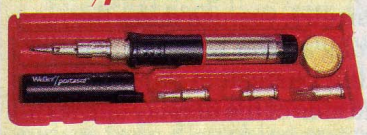

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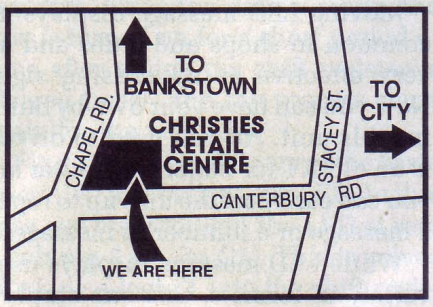

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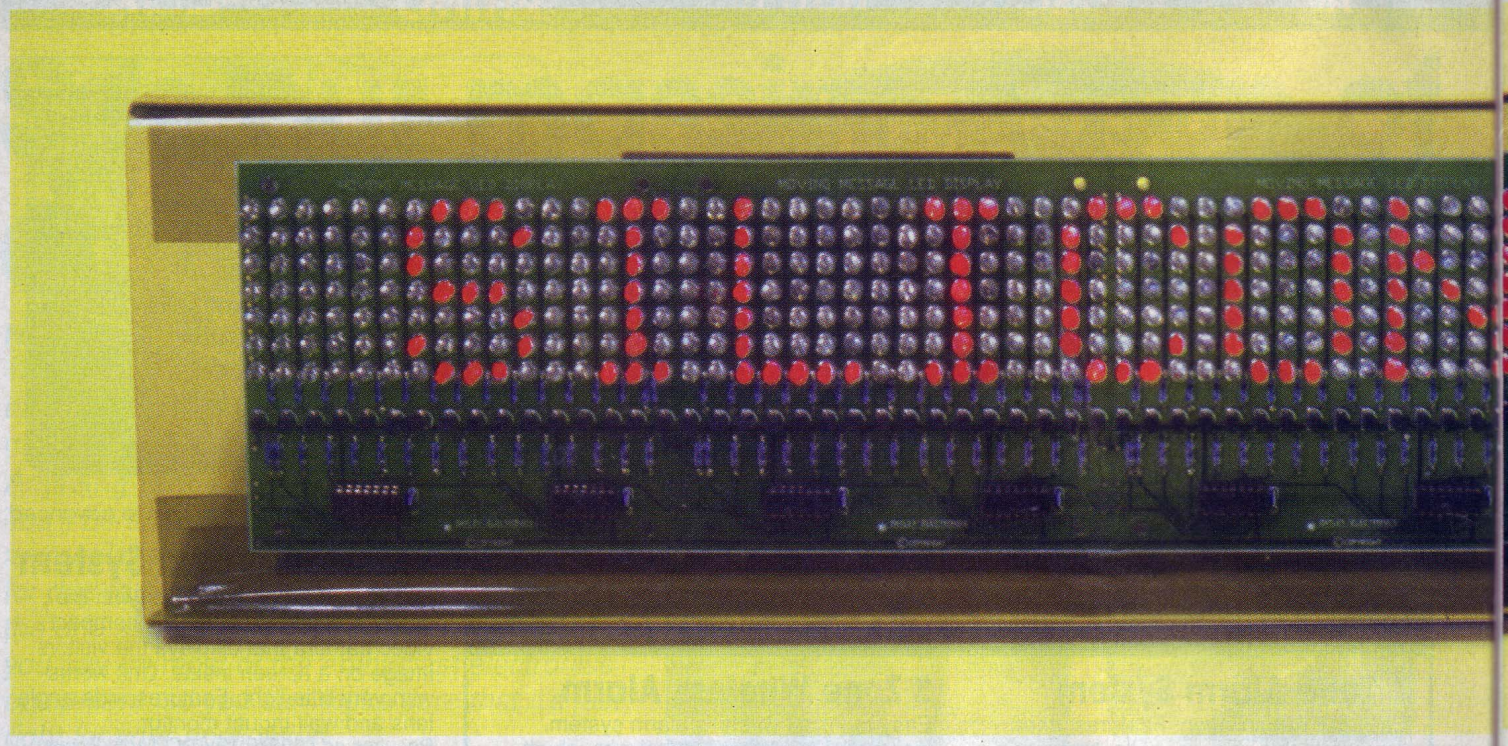


PC-controlled moving message display

Have you got an old PC sitting around gathering dust? You can use it to control this moving LED message display which plugs into the PC's printer port. All you have to do is type the message in on the keyboard.

Design by JOHN WESTERN

Moving LED message displays are common in shops and clubs and are very effective as advertising signs. Now you can have your own by building this unit. All you need to drive it is an old XT (or better) computer and you can easily set the unit up to repeat a message or a number of messages.

While LED message displays use a variety of formats, this one employs characters which are seven LEDs high by five LEDs across and these move along the LED array at a fixed rate.

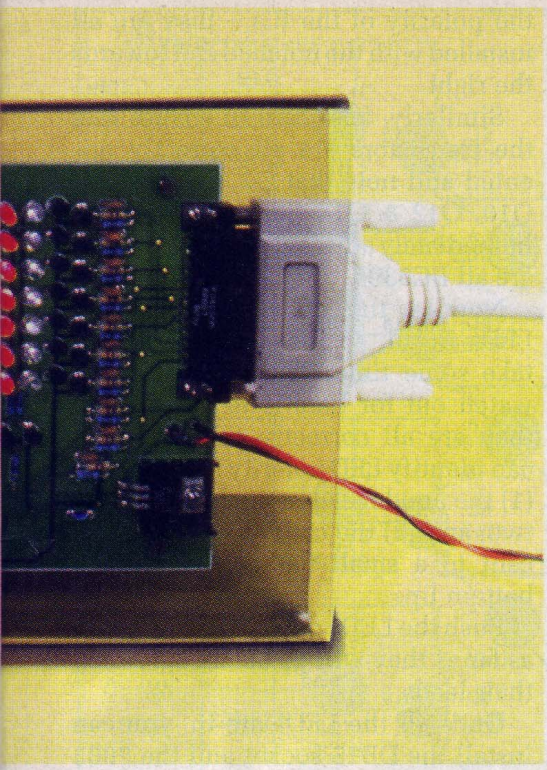
As presented here, the display consists of a 48 x 7 LED matrix arranged on a single large PC board. This board basically consists of three 16 x 7 LED modules: a master module which also contains the necessary parallel port interface circuitry, and two extension modules. Each module has enough LEDs to display three characters, which means that the basic unit can display up to nine characters at any given time.

If you wish, you can increase the display width by adding another one or two extension modules. This will allow either 12 or 15 characters to be displayed at any one time. The additional extension modules are simply cut from a second PC board and connected to the lefthand end of the message display using 12 wire links.

Conversely, you can reduce the display width by cutting off one of the extension modules, to give a 32 x 7 (6-character) LED display.

Of course, the length of the message is not limited by the number of characters that can be displayed at any one time. Basically, you can make the message as long as you like. In operation, the leading characters appear on the righthand side of the display and scroll across to the lefthand side before disappearing off the "edge". The message continues scrolling until all the characters have been displayed and can easily be set up so that it repeats.

Our prototype was built to the standard 9-character configuration; ie, a single PC board with three modules. This is housed in a folded smoked-Perspex case to produce an attractive display. It is powered by a 12V AC plugpack



and is connected to the parallel port of the PC via a DB25 socket mounted on one end of the board.

How it works

Each character to be displayed is produced by turning on all the appropriate LEDs in a row for a short period of time. This is repeated for each of the seven rows, to make up the character in a multiplexed fashion. Because this happens at a very high rate, all the LEDs appear to be turned on at the same time.

Fig.2 shows the circuit diagram of the Moving LED Display. Each row of LEDs is driven by a Darlington transistor pair consisting of a BC549 and a BC639; ie, Q1 & Q2 for row 1, Q3 & Q4 for row 2, etc. These seven Darlington transistor pairs are in turn driven by the printer port data lines.

Note that each line from the printer port is filtered by an RC network consisting of a 47Ω resistor and a 220pF capacitor. These filters prevent noise pulses from disturbing normal operation of the display.

The LED columns are controlled by separate BC549 transistors (Q15, Q16, etc), in turn driven by 74LS164 shift registers (one for each group of eight columns). These shift registers accept the serial data applied to their A & B data inputs and convert it to parallel format at their Q0-Q7 outputs. So each shift register controls eight transistors and thus eight LED columns.

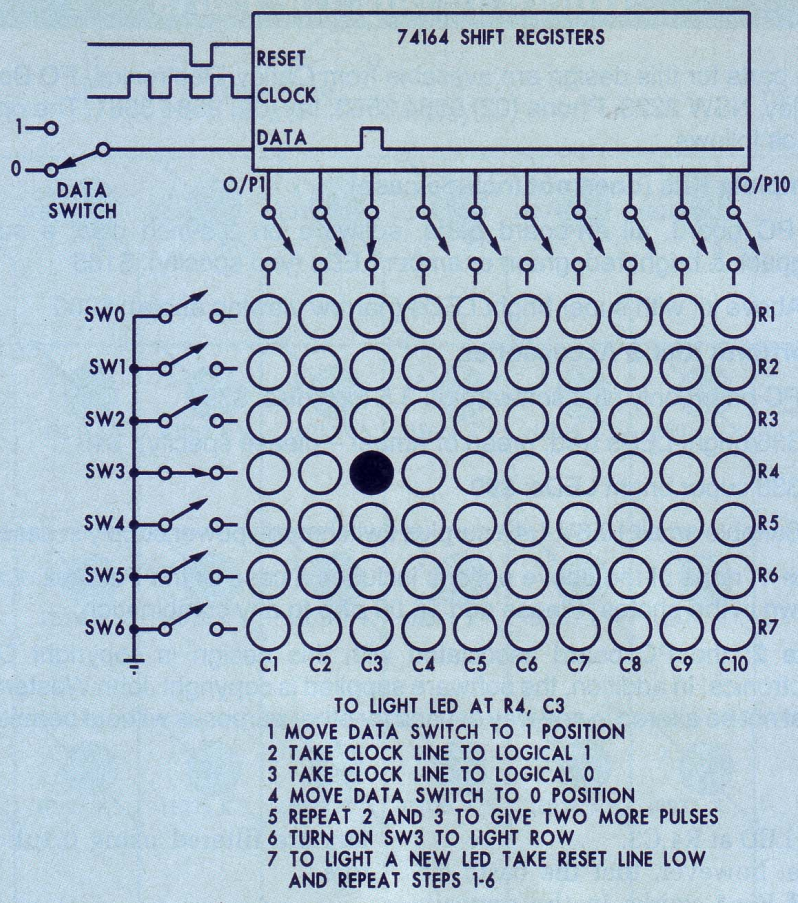


Fig.1: this diagram gives a breakdown of the basic operation just to light one LED. In this case, we want to light the LED at row 4 column 3 (ie, R4,C3). This involves clocking a logic 1 into the shift register and then moving it until the third output goes high, represented here by the closed switch between the shift register and C3. Switch SW3 is then closed to light the row

Note that, for the sake of clarity, our circuit only shows the first eight LED columns, their corresponding transistors (Q15-Q22) and one shift register (IC1). The circuitry for each successive eight columns is identical, with pin 13 of IC1 clocking the data inputs of the next shift register, and so on down the chain.

IC1 is driven by one of the parallel printer port data lines, while two other data lines drive the clock and reset pins (pins 9 & 8). Basically, data is shuffled into IC1 in serial fashion and its appropriate Q outputs go high, thereby turning on the corresponding column transistors. One of the row data lines is then briefly taken high to light the required LEDs.

In greater detail, the character to be displayed is broken down into the required pattern of dots for each row. Initially, the shift registers are all cleared by applying a pulse to the MR line. This sets all outputs to a logical low condition, turning all columns off.

The required data is then applied to the A & B data inputs and the CLK line pulsed to move the data into the first shift register. Successive data is subsequently applied in a similar fashion until the required pattern of dots for a particular row is set up in the shift registers. Once the data is ready, the row is turned on for a short period of time after which the shift register is cleared (reset) and the process starts again for the next row.

Fig.1 gives a breakdown of the basic operation just to light one LED. In this case, we want to light the LED at row 4 column 3 (ie, R4,C3). This involves clocking a logic 1 into the shift register and then moving it until the third output goes high, represented here by the closed switch between the shift register and C3. Switch SW3 is then closed to light the row, in this case the

Where To Buy The Parts

The parts for this design are available from Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563; fax (02) 9584 3561. The options are as follows:

Complete Kits (does not include case)

(1) PC board, all on-board parts, software on 3.5-inch disc, a surplus plugpack & bright red, green or amber LEDs (you specify): $165

(2) Above kit with super bright LEDs (narrow viewing angle): $200

Shortform Kits & Accessories

(3) PC board only plus software on 3.5-inch disc: $75

(4) 336 bright LEDs (red, green or amber – please specify): $45

(5) 336 super bright LEDs: $90

(6) Suitable small 10.6V 1.4A surplus switchmode power supply in case: $12

Note 1: none of the above options includes a case or the Perspex channel shown in the photos. Please add $6.00 p&p to any combination.

Note 2: the PC board associated with this design is copyright Oatley Electronics. In addition, the software supplied is copyright John Western and must not be altered in any way or used for other purposes without permission.

single LED at R4,C3.

Note, however, that the basic circuit of Fig.1 works in the opposite sense to the circuit of Fig.2. In reality, the shift registers drive transistors and these provide logic lows, while the printer port data lines and their associated Darlington transistors pull the rows high.

To sum up, the printer port data lines pull each row high in succession to light the appropriate LEDs. And in between times, the shift registers are reset and new data appropriate for the next row is clocked in. Add to this the fact that the display moves from left to right and you can see that the timing process is quite complicated.

Fortunately, that's all taken care of by a machine language program which is called LEDs.COM. This program manipulates all the control lines from the printer port to control the LED display.

Power supply

The display is powered from a 9-12V DC plugpack rated at 1A. The DC rail from the plugpack is applied to REG1, which delivers a regulated 5V rail to power the LED arrays and the shift registers.

The 10µF and 1µF capacitors at the input and output of REG1 are there to ensure regulator stability. In addition, the supply pins of all the shift registers are filtered using 0.1µF capacitors

Construction

This design is available as a complete kit of parts from Oatley Electronics, who own the copyright on the PC board (see pricing panel). The board is double-sided with plated-through holes which means that there are no links to install. It is also solder-masked and carries a screen printed overlay to make the job of assembly as straightforward as possible.

As mentioned earlier, the basic configuration is a 3-section board with a 48 x 7 LED array. Each section (or module) contains 16 LED columns plus a pair of matching shift registers. In addition, the master module carries the DB25 socket plus the Darlington transistors and power supply components.

Fig.3 shows the parts layout on the PC board. Note that this only shows the master module plus part of the first extension module. The pattern of LEDs, shift register ICs and other parts simply repeats towards the left.

Begin the assembly by installing the resistors and capacitors, then add the transistors and the ICs. The use of IC sockets is recommended here, since a dud IC (rare) is very difficult to remove if it is soldered directly to a double-sided board. Take care with the polarity of the ICs – they are all installed with the notched end towards the right.

Similarly, take care to ensure that the transistors are all correctly oriented and note that Q2, Q4, Q6, Q8, Q10, Q12 & Q14 (ie, the transistors immediately adjacent to the LED rows) are all BC639s.

Now for the LEDs. There are 336 LEDs in all, so installing them will take some time. The main thing to watch out for here is to ensure that they are all correctly oriented. You can identify LED polarity in two ways: (1) the anode lead is the longer of the two; and (2) the cathode lead is adjacent to a small flat section on the bottom lip.

Push the LEDs down onto the board as far as they will go before soldering their leads.

Once all the LEDs are in, you can install the DB25 socket and the 7805 regulator (REG 1). The latter is installed with its leads bent at right angles and its metal tab bolted to the PC board along with a small finned heatsink.

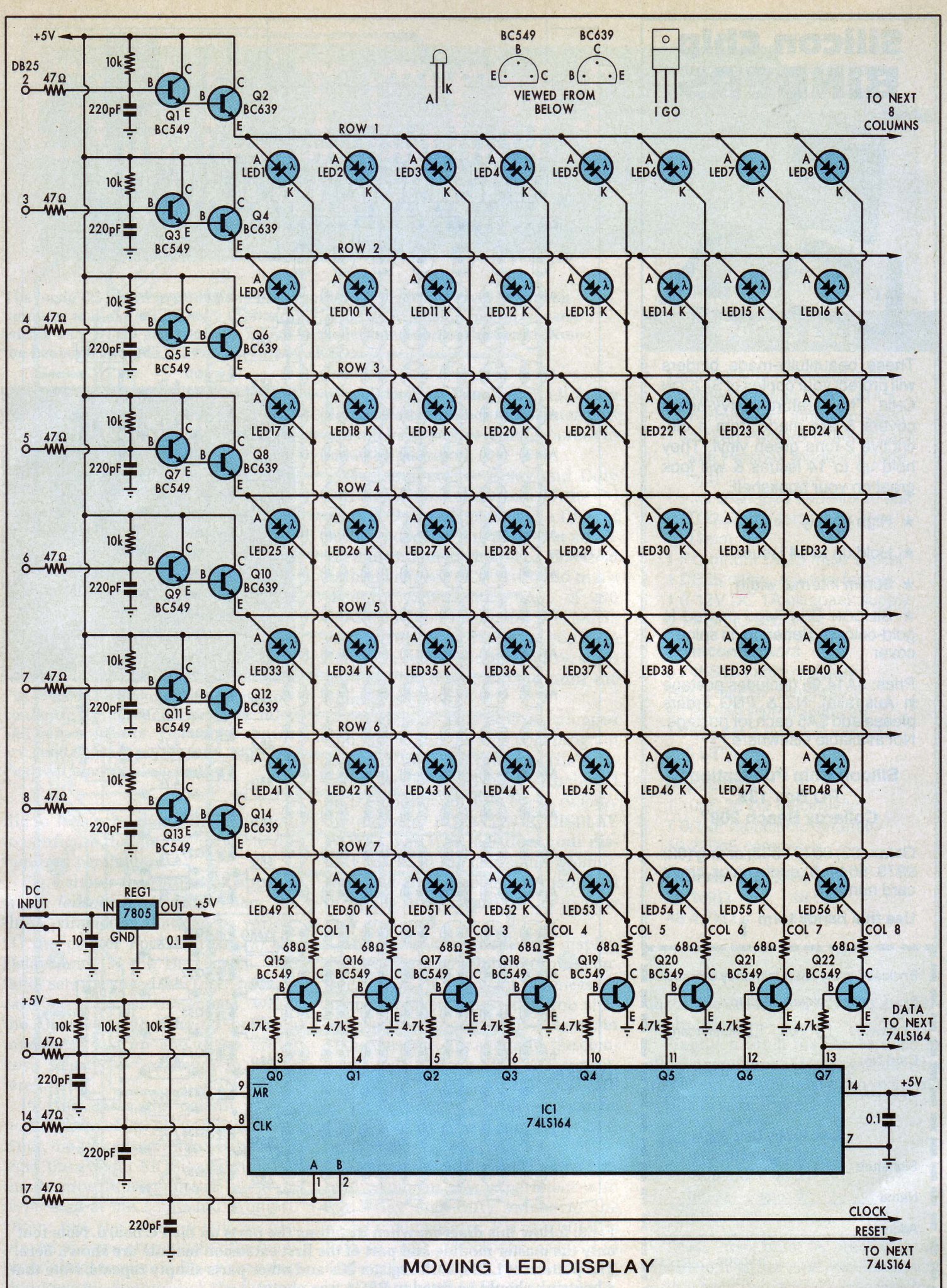
The prototype board was installed in a smoked Perspex channel (470mm long x 150mm high) and secured using machine screws and nuts at the back. This Perspex channel was bent up by a local plastics supplier. Alternatively, you can make up a suitable wooden or metal case with a Perspex viewing window for the LED arrays.

Software & testing

The software for the Moving LED Display comes on a 3.5-inch floppy disc and consists of six main files plus a brief readme file. The files *leds3.com*, *leds4.com* and *leds5.com* are for displays with from three to five modules (including the master module), while the *ledset.com* file configures the basic setup.

First, copy the correct *leds_.com* file to the hard disc (or to another floppy), along with the *ledset.com* file. Next, rename the copied *leds_.com*

Fig.2 (right): the Moving LED Display is controlled via the PC's parallel port. The rows are driven by Darlington transistor pairs, while the data in the shift registers (IC1, etc) controls the column switching transistors (Q15, Q16, etc).



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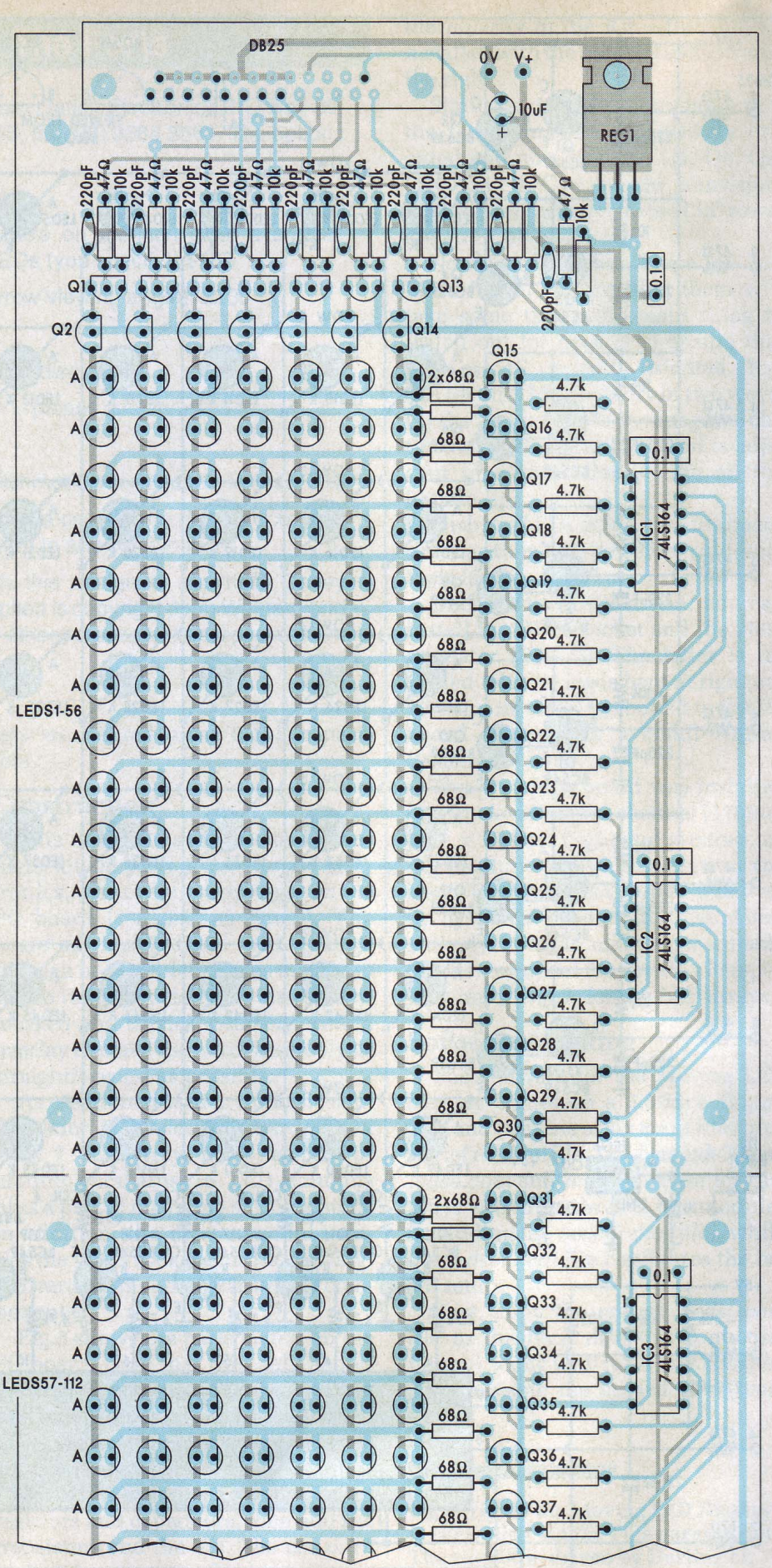
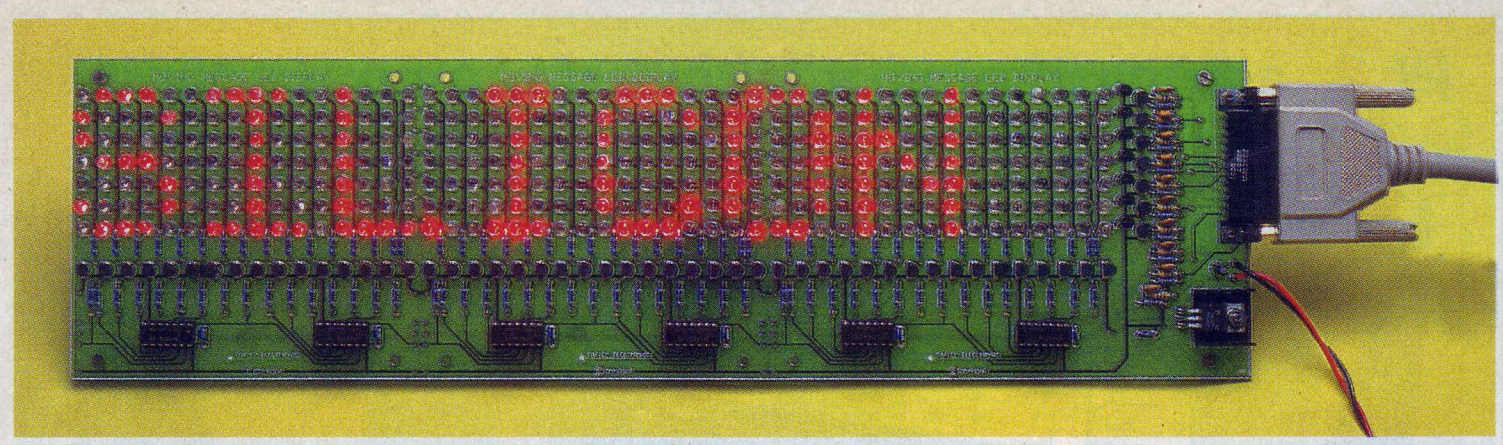


Fig.3: follow this diagram when installing the parts on the PC board. Note that only the master module and part of the first extension module are shown here. The pattern of LEDs, shift register ICs and other parts simply repeats. Note that a heatsink should be fitted to REG1 (see photo).



The basic PC board includes a master module (at right) plus two extension modules to make up a 48 x 7 LED array. Up to two extension modules, each with a 16 x 7 LED array, can be added to the lefthand end of the board. Note the heatsink fitted to the 7805 regulator (REG1).

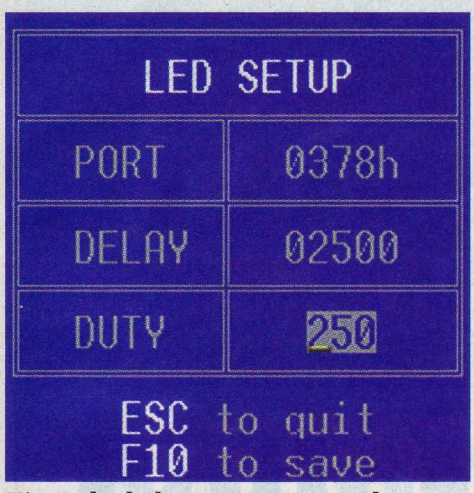


Fig.4: the ledset.com program lets you configure the ledsx.com program to suit your computer. The values shown are good starting points for a 133MHz Pentium machine (see text).

file to *leds.com*, then run *ledset.com* to configure the display driver to the required parameters.

Fig.4 shows the setup that appears when *ledset.com* is run. There are three parameters that can be varied: (1) the printer Port address; (2) the Delay; and (3) the Duty cycle. The latter sets the speed at which the message move across the screen, while the Delay sets the period between messages. The up and down arrow keys select the parameter to be altered.

In most cases, the default printer port address of 0378H will be correct. If not, the address can either be gleaned from the system BIOS or by running the Microsoft Diagnostics program (type msd at the command prompt). Often, too, the address will be displayed at some stage during the computer's boot sequence. If you are using Windows 95, double click the System icon in Control Panel, then click the Resources tab, select the printer port and click Properties and Resources to view the address.

The numbers for Delay and Duty will depend on the speed of the PC used. A Delay of 00500 and a Duty of 001 are good starting points for an XT but these numbers should be increased for higher speed PCs. We found that a Delay of 02500 and a Duty of 250 produced good results on a 133MHz Pentium machine. Note that you have to type in each digit in an entry, starting from the leftmost digit, until the number is correct.

The display can now be plugged into the PC and the *leds.com* program run from the DOS prompt. The message to be displayed must be included on the command line; eg, to display the message **DOES YOUR DISPLAY WORK?**, you type **leds does your display work?** at the command prompt. Note that all characters are displayed in upper case, regardless as to how they are typed.

The above command will display the message once before returning control to DOS. If you want the message to be displayed repeatedly, you simply use a full stop as the first character of the message. For example, the command **leds .silicon chip** will repeatedly cycle the message **SILICON CHIP** across the display. The display can be stopped at any time by pressing Ctrl C on the computer keyboard.

Assuming that the unit works correctly, you can now experiment with the Delay and Duty values in the ledset.com program. If a row of LEDs fails to light, check the associated Darlington transistor pair. Similarly, if a column of LEDs fails to light, check the associated column switching transistor.

Finally, a batch file can be used to allow a sequence of messages are to be displayed continuously. An example of this is as follows:

```
:start
leds message 1
leds message 2
leds message 3
goto start
```

These lines must be created in an ASCII text editor and the file saved with a *bat* extension; eg, *message.bat*.

PARTS LIST

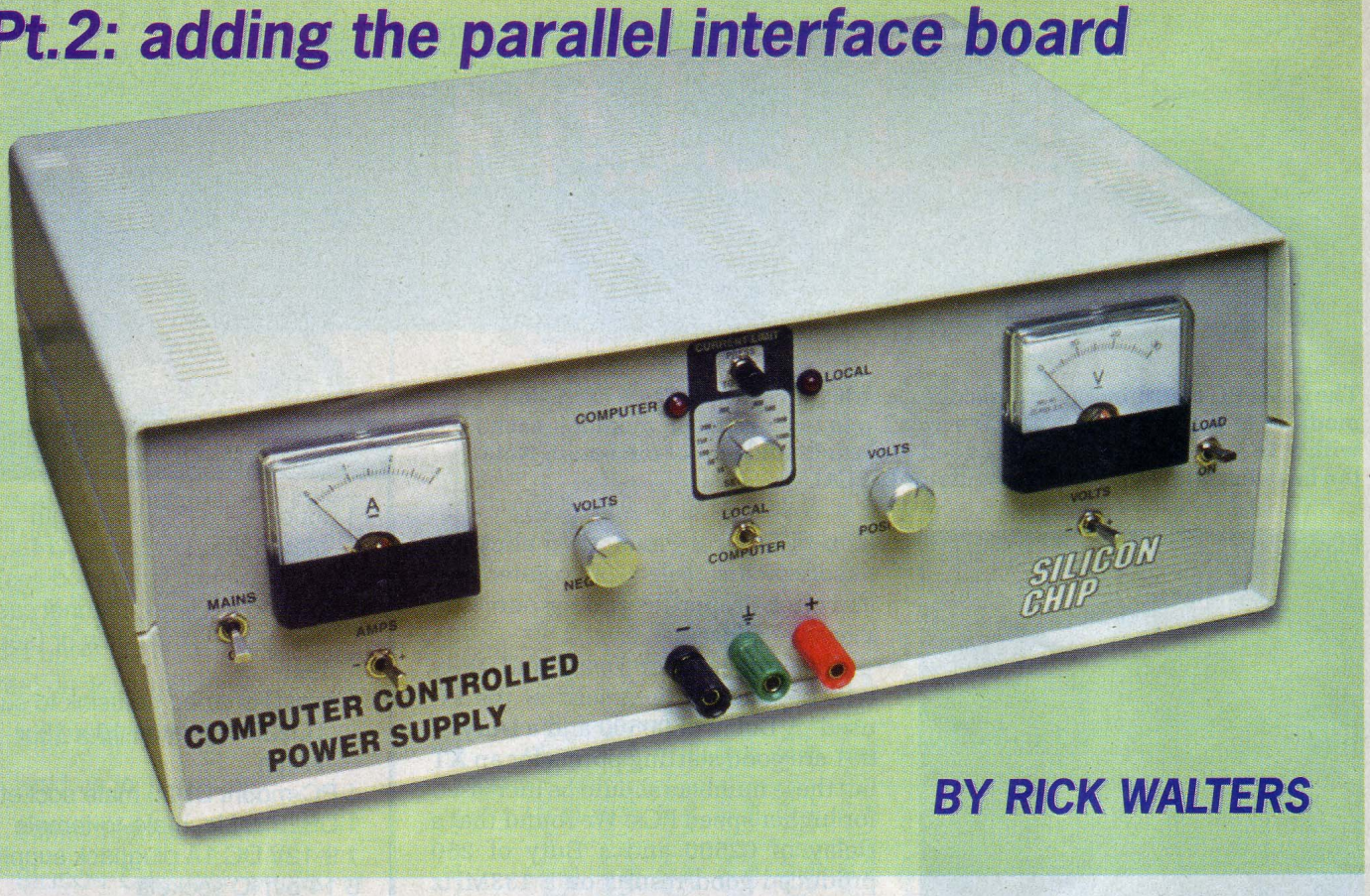
1 double-side PC board with plated-through holes, 414 x 107mm (incl. three modules)
1 smoked Perspex channel case with Perspex window or (see text)
1 mini U-shaped heatsink to suit TO220 regulator, 19 x 19 x 11mm
1 PC-mount DB25 male socket
1 DB25 cable, male-to-female
1 9-12V DC 1A plugpack supply
6 14-pin IC sockets

Semiconductors
6 74LS164 shift registers
7 BC639 PNP transistors
55 BC549 PNP transistors
1 7805 5V 3-terminal regulator
336 LEDs

Capacitors
1 10µF 25VW electrolytic
7 0.1µF monolithic ceramic
10 220pF ceramic

Resistors (0.25W, 5%)
10 10kΩ 48 68Ω
48 4.7kΩ 10 47Ω

Pt.2: adding the parallel interface board



BY RICK WALTERS

Computer controlled dual power supply

Last month, we presented the standalone version of this power supply. By building & fitting the interface board described here, you will be able to control it from your computer.

The power supply interface board connects via a 25-way cable to the parallel port of your computer. The interface allows your computer to perform two functions. The first is to set the required positive and negative output voltages and current limit which will be delivered by the power supply. The second is to display the actual voltage and current from the power supply on the computer's video monitor.

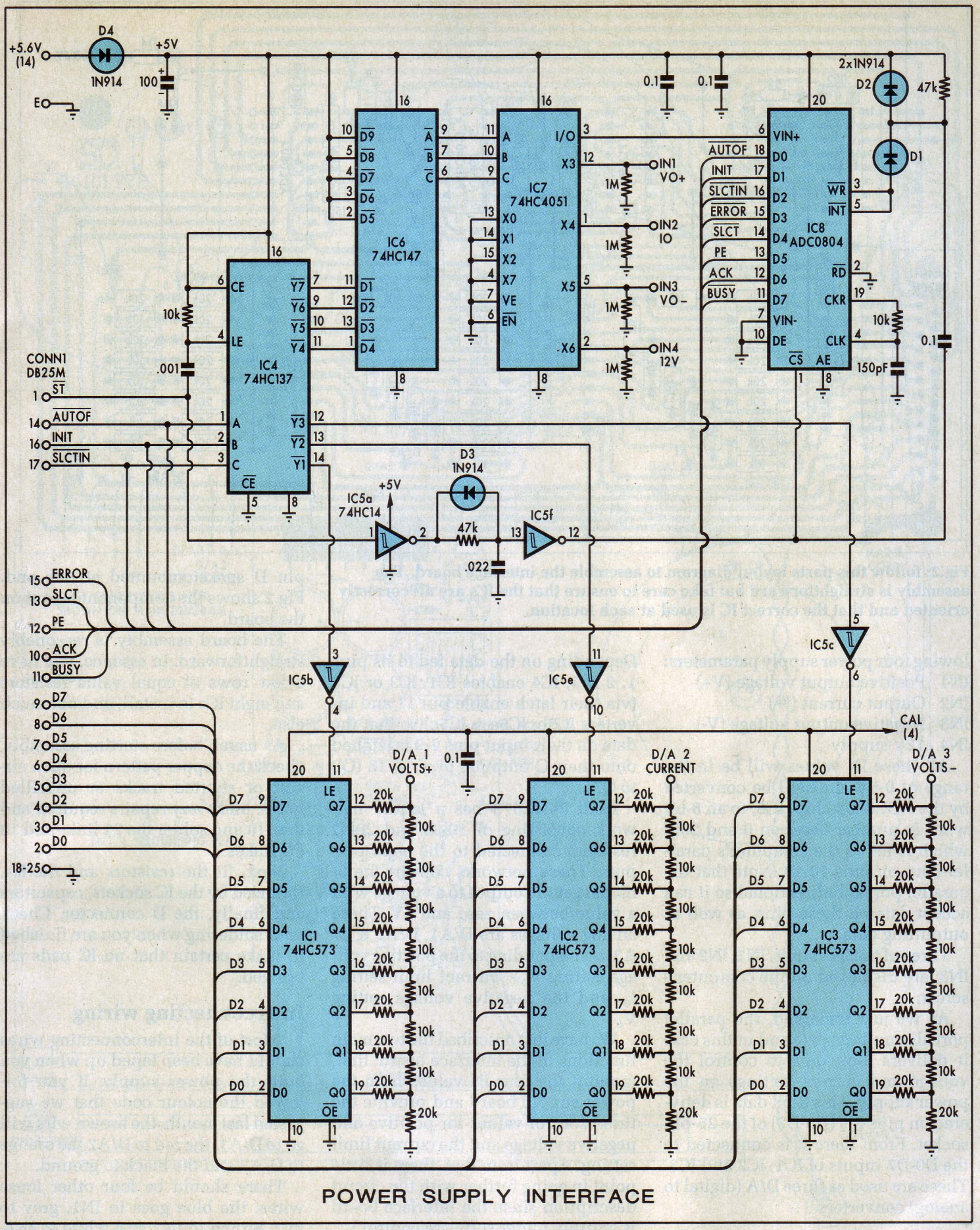
Normally the voltages set by the computer will be the same as those displayed but if the power supply goes into current limit, the associated output voltage will be reduced.

One good feature of the computer control is the ability to use the settings which were in use the last time the supply was turned off. These settings are stored in a file which is read each time the software is run. This gives you the option of using the same supply values and printer port as previously or selecting new values or a different printer port.

Now let's have a look at the circuit of Fig.1 and even the most dyed-in-the-wool computer hardware enthusiast would have to admit that it's not too inspiring. However, before you turn the page and give up, let's note a few key points.

First, if you refer to the circuit presented last month, you will note that there are four outputs labelled IN1, IN2, IN3 & IN4 and three inputs labelled D/A1, D/A2 & D/A3.

The outputs from the power supply board become the four inputs for the A/D converter on the interface board. They are fed to IC7, a 74HC4051 1-of-8 multiplexer. Depending on the BCD



data at its ABC inputs, it feeds the selected IN value through to IC8, the ADC0804 analog-to-digital converter. The four IN values relate to the fol-

Fig.1: the circuit allows data from the computer's printer port to set the supply's voltage and current outputs. It also allows the voltage and current to be monitored on the computer screen. Octal latches IC1, IC2 and IC3 are used as D/A converters and are controlled by IC4, a 74HC137 latched one-of-eight decoder.

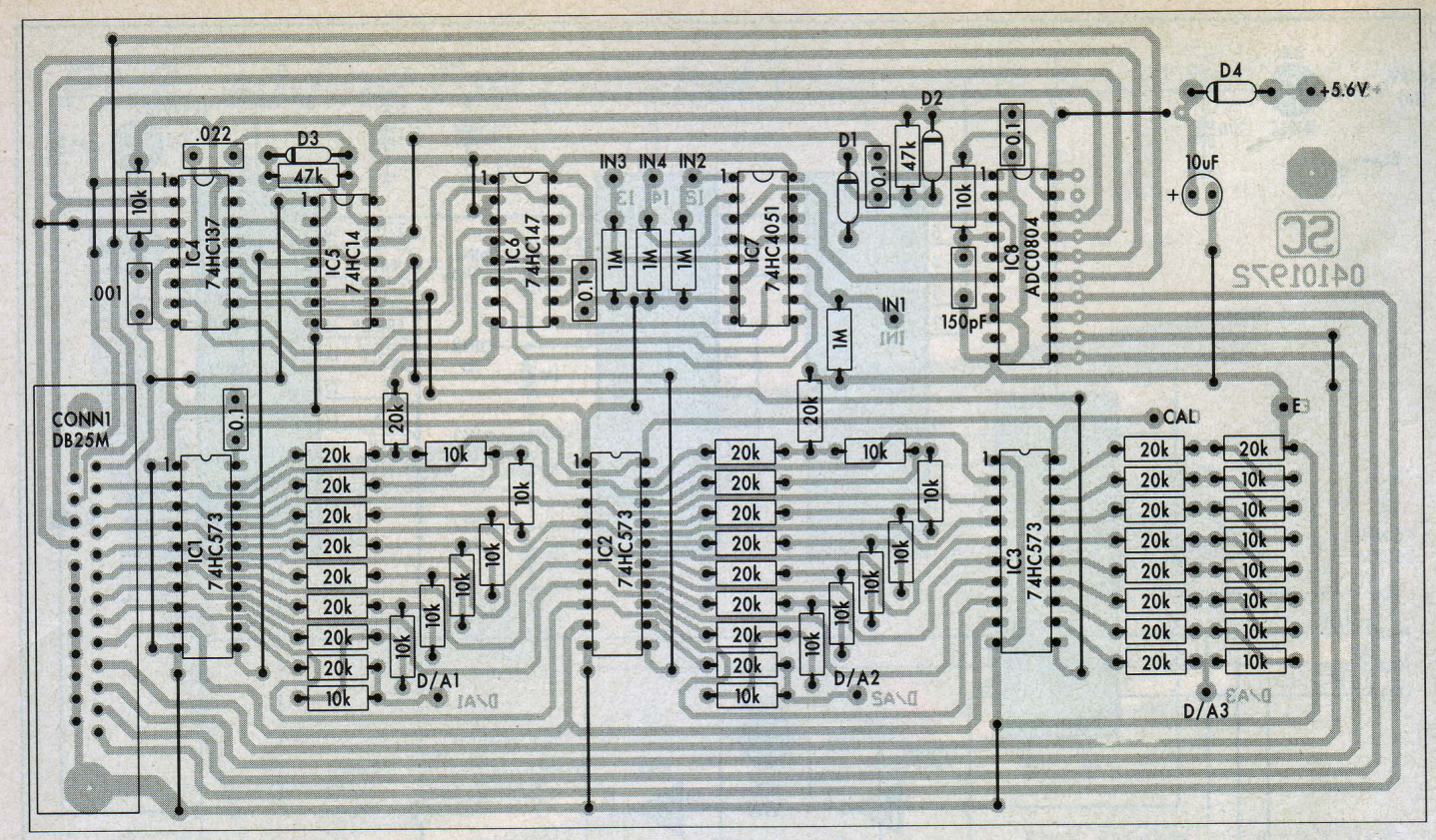


Fig.2: follow this parts layout diagram to assemble the interface board. The assembly is straightforward but take care to ensure that the ICs are all correctly oriented and that the correct IC is used at each location.

lowing four power supply parameters:

IN1 Positive output voltage (V+)
IN2 Output current (I+)
IN3 Negative output voltage (V-)
IN4 12V supply

All these IN values will be in the range of 0-5V and will be converted by the ADC0804 chip, IC8, to an 8-bit word (a number between 0 and 255) which is fed to the computer's parallel port, on pins 10-17. Note that the parallel port is bidirectional so it can accept data on these pins, as well as outputting data.

Three of the IN values, IN1, IN2 and IN3, are displayed on the computer's screen.

As we just remarked, the parallel port also outputs data and in this case it delivers 8-bit data to control the voltage and current settings on the power supply. This 8-bit data is delivered on pins 2-9 (D0-D7) of the 25-pin socket. From there it is connected to the D0-D7 inputs of IC1, IC2 and IC3. These are used as three D/A (digital to analog) converters.

Digital to analog converters

IC1, IC2 and IC3 are octal (8-bit) latches under the control of IC4, a 74HC137 latched one-of-eight decoder. Depending on the data fed to its pins 1, 2 & 3, IC4 enables IC1, IC3 or IC3 (via their latch enable pin 11 and inverters IC5b, IC5e & IC5c) so that the data on their input pins 2-9 is latched onto their Q outputs, pins 19-12 (Q0 to Q7).

Each 74HC573 has a ladder network consisting of 10kΩ and 20kΩ resistors connected to the eight outputs. These networks convert the 8-bit data at the output to a voltage with a value between zero and 5V. These analog voltages are D/A1, D/A2 & D/A3, corresponding to the positive voltage setting V_O+, current limit setting I_O, and the negative voltage setting V_O-.

We have just described the two main functions of the interface board: first, monitor the four IN values from the power supply board and provide the three control values for positive and negative voltage and the current limit setting. Apart from that, there is little point in going further with the circuit description since the interface board is entirely under software control.

PC board assembly

The interface board measures 178 x 100mm (code 04101972) and has a 25-pin D socket mounted at one end. Fig.2 shows the component layout on the board.

The board assembly is reasonably straightforward. In essence, you have a few rows of equal value resistors and eight ICs to install, and not much else.

As usual, before starting assembly, check the copper pattern for open circuit or shorted tracks or undrilled holes. Make any repairs required and then fit and solder the 21 links and 10 PC stakes.

Next, fit the resistors and diodes, followed by the IC sockets, capacitors and finally, the D connector. Check your soldering when you are finished to make certain that no IC pads are bridged.

Interconnecting wiring

Most of the interconnecting wires should have been taped up when you built the power supply. If you followed the colour code that we suggested last month, the brown wire will go to D/A1, the red to D/A2 the orange to D/A3 and the black to ground.

There should be four other loose wires: the blue goes to IN1, grey to IN2, brown to IN3 and white to IN4. Two leads need to be run from the anode of D3 to TP14 and from the remaining PC stake to TP4 on the power supply board.

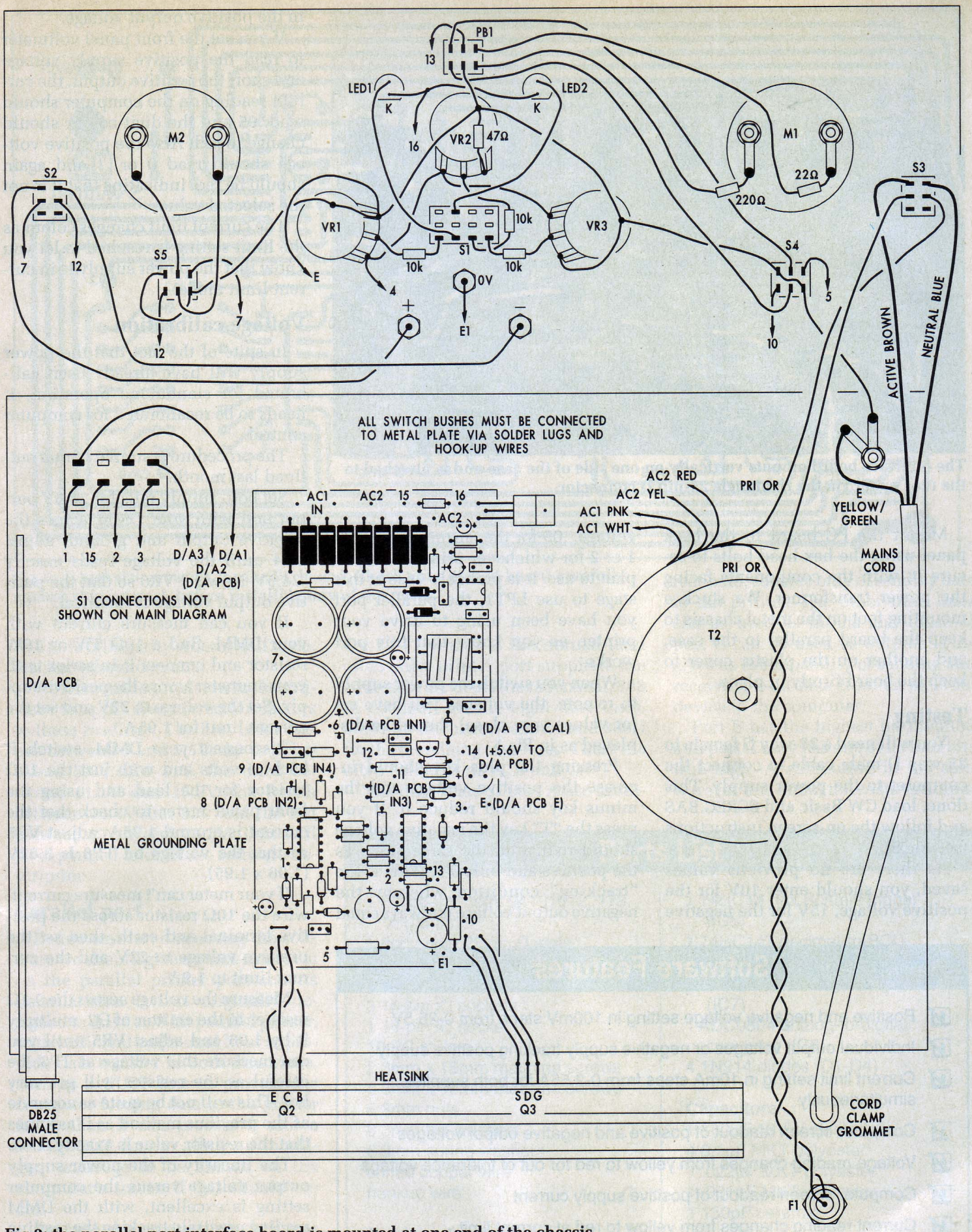
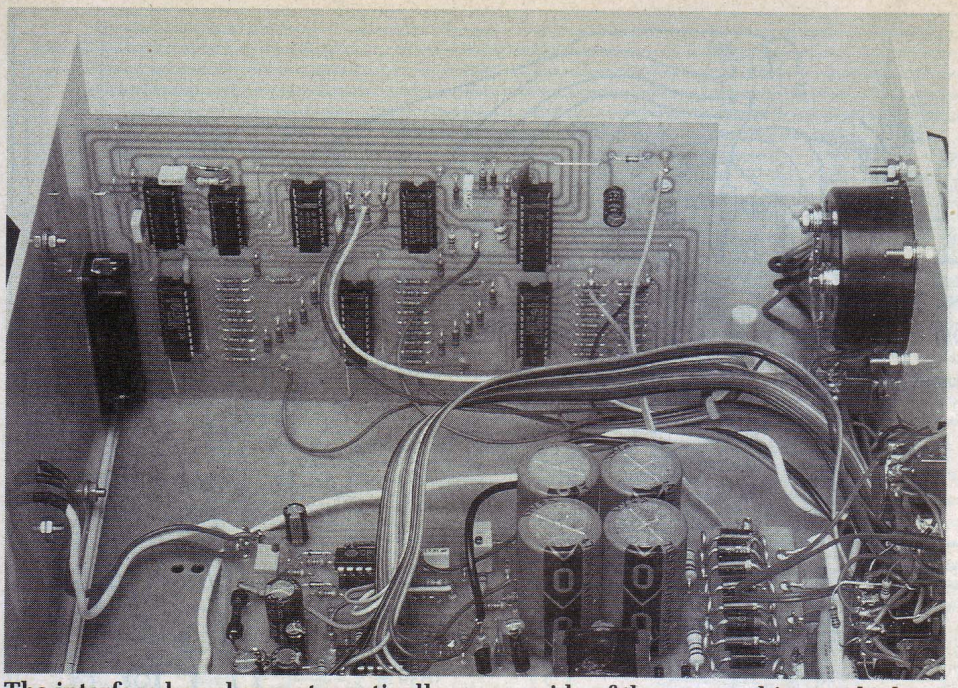


Fig.3: the parallel port interface board is mounted at one end of the chassis, with the DB25 connector protruding through the rear panel. Use this chassis wiring diagram and the wiring table from last month's issue to make the off-board connections. Because only low currents are involved, you can run the connections to the interface board using rainbow cable



The interface board mounts vertically on one side of the case and is attached to the rear panel via the rightangle 25-pin D connector.

Mount the PC board to the back panel using the hex head bolts to secure it, with the components facing the power transformer. We stuck a mounting foot on the metal chassis to keep the board parallel to the case, and another on the plastic cover to keep the board firmly in place.

Testing

You will need a 25-way D female to 25-way D male cable to connect the computer to the power supply. This done, load GW Basic and SCREG.BAS and follow the on-screen instructions (see Fig.5).

As there are no previous values saved, you should enter 10V for the positive voltage, 15V for the negative voltage, .05 for the current limit, and 1 or 2 for whichever printer port you plan to use. It is probably wise at this stage to use LPT1, the parallel port you have been using to drive your printer, as you know that this port works.

When you switch the power supply to remote, the voltages you have set (or values very close) should be displayed as in Fig.5.

Pressing the plus key should increase the positive voltage and the minus key should reduce it. If you press the "T" key the negative voltage should reduce to the same value as the positive and follow it. This is the "tracking" condition whereby the negative output voltage is always equal to the positive output voltage.

If you set the front panel voltmeter to read the positive supply voltage and short the positive output, the current reading on the computer should read .05 and the digit colour should change to red. Also the positive voltage should read 0 or .1 and again should be red, indicating that it is not the selected value.

The current limit changes colour as the limit setting is reached to let you know that the power supply is in current limit mode.

Voltage calibration

In spite of the fact that the power supply will have already been calibrated for standalone operation, it needs to be recalibrated for computer control.

The procedure is similar to that outlined last month.

Set both supply rails for 24.5V output and with your DMM across the negative output and ground, adjust VR4 until the voltage reads exactly -24.5V. Now set VR6 so that the positive output voltage is identical.

If you can measure current with your DMM, find a 10Ω 5W or 10W resistor and connect it in series with your ammeter across the positive supply. Set the voltage to 22V and set the current limit for 1.95A.

Disconnect your DMM, switch it back to volts and with just the 10Ω resistor for the load and using the front panel meter to check that the current is around 1.95A, adjust VR5 so that the voltage on TP8 is 3.82V (1.96 x 1.95).

If your meter can't measure current, wire the 10Ω resistor across the positive terminal and earth, then set the positive voltage to 22V and the current limit to 1.9A.

Measure the voltage across the 0.1Ω resistor in the emitter of Q2, multiply it by 1.96 and adjust VR5 until you can measure this voltage at TP8. Be careful as the resistor will get very hot. This will not be quite as accurate as the previous method as it assumes that the resistor value is exactly 0.1Ω.

The linearity of the power supply output voltage versus the computer setting is excellent, with the DMM reading precisely tracking the reading on the computer screen.

The voltage fed back to the computer is not quite as linear. There are slight errors in the converted voltages

Software Features

- ☑ Positive and negative voltage setting in 100mV steps from 0-25.5V
- ☑ Individual output voltages or negative supply tracking positive supply
- ☑ Current limit setting in 10mA steps from 0-2.55A for both supplies simultaneously
- ☑ Computer screen readout of positive and negative output voltages
- ☑ Voltage reading changes from yellow to red for out of tolerance voltage
- ☑ Computer screen readout of positive supply current
- ☑ Current reading changes from yellow to red at current limit
- ☑ Selection of printer port 1 or 2
- ☑ All settings are saved and can be restored at program start

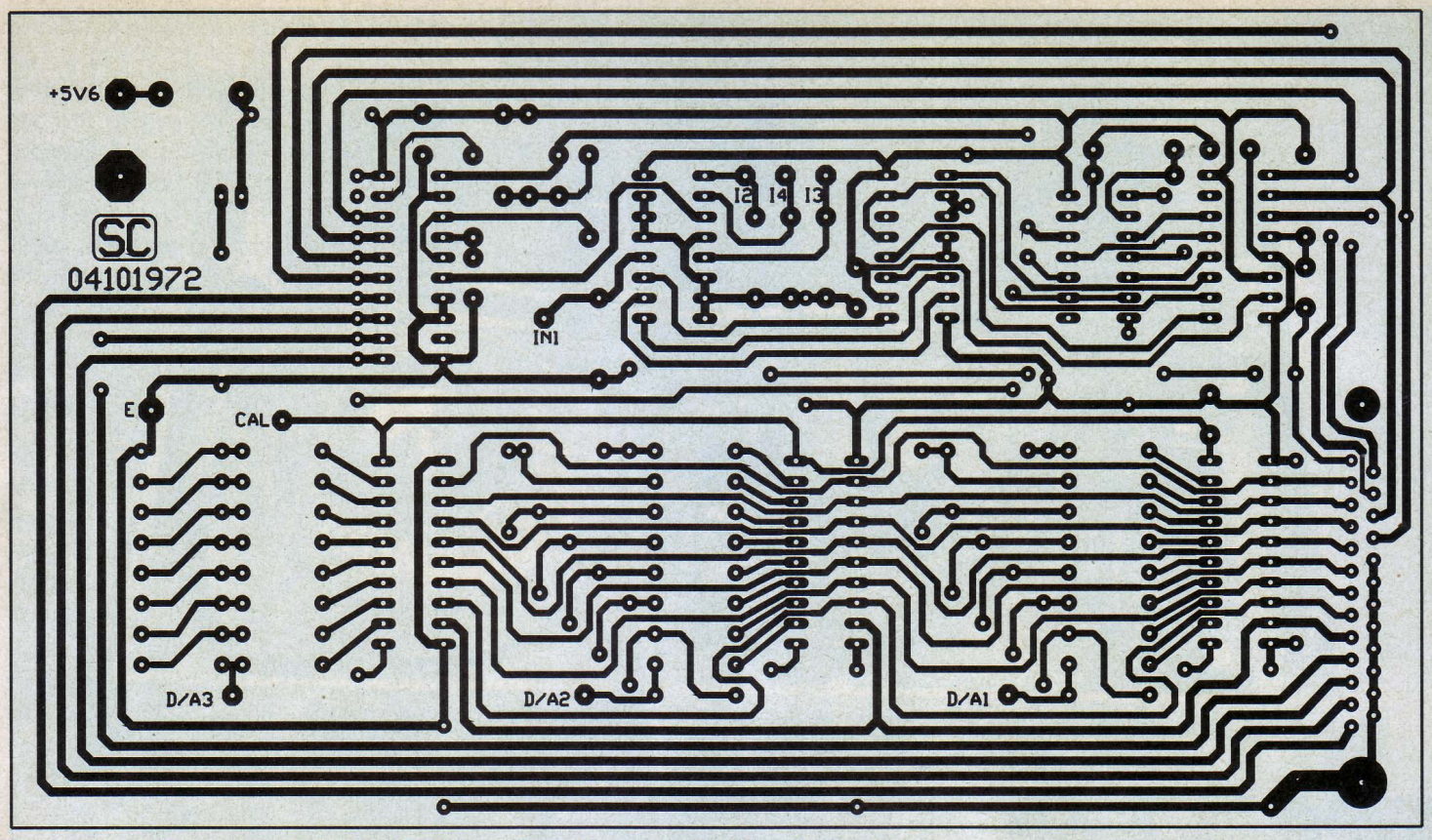


Fig.4: actual size artwork for the PC board. Check your etched board carefully against this artwork before installing any of the parts.

due to A/D linearity around half scale, resistor tolerances, etc.

We have made provision in the software to apply five correction factors to these readings. The first is for values between 0 and 5.5V, the next between 5.6V and 11V, the third between 11.1V and 16.5V, the fourth between 16.6V and 22V and the last between 22.1V and 25.5V. This will be explained later in the software description.

Parallel port

Before we start discussing the software we should give a quick rundown on the parallel printer port and its peculiarities. It was originally designed to drive an 8-bit parallel printer, with sufficient additional lines to provide data transfer in both directions, such as a BUSY line to prevent the computer feeding data to the printer faster than it can process it and a PAPER OUT line to allow an intelligent message to be shown on the computer's screen if this should occur.

Because the original interface was for a Centronics printer, some bits are true high, others are true low.

These signal lines are split over three addresses on the IBM interface. For LPT1 which is the normal (and often only) printer port supplied, the addresses are 378H (hexadecimal, 888 in decimal) for the eight data lines, 379H for the next five lines and 380H for the remaining four lines. These are often called ports A, B and C.

The data lines of port A are unidirectional, capable only of sending data to the printer. The other nine lines can be used as inputs and those of port C can be used as outputs. This gives us the capability of sending and receiving 8-bit data from an external device to the computer.

Port B has the highest bit inverted and port C only has one of its four bits true high. A subroutine in the software (at line 3000) untwists the input

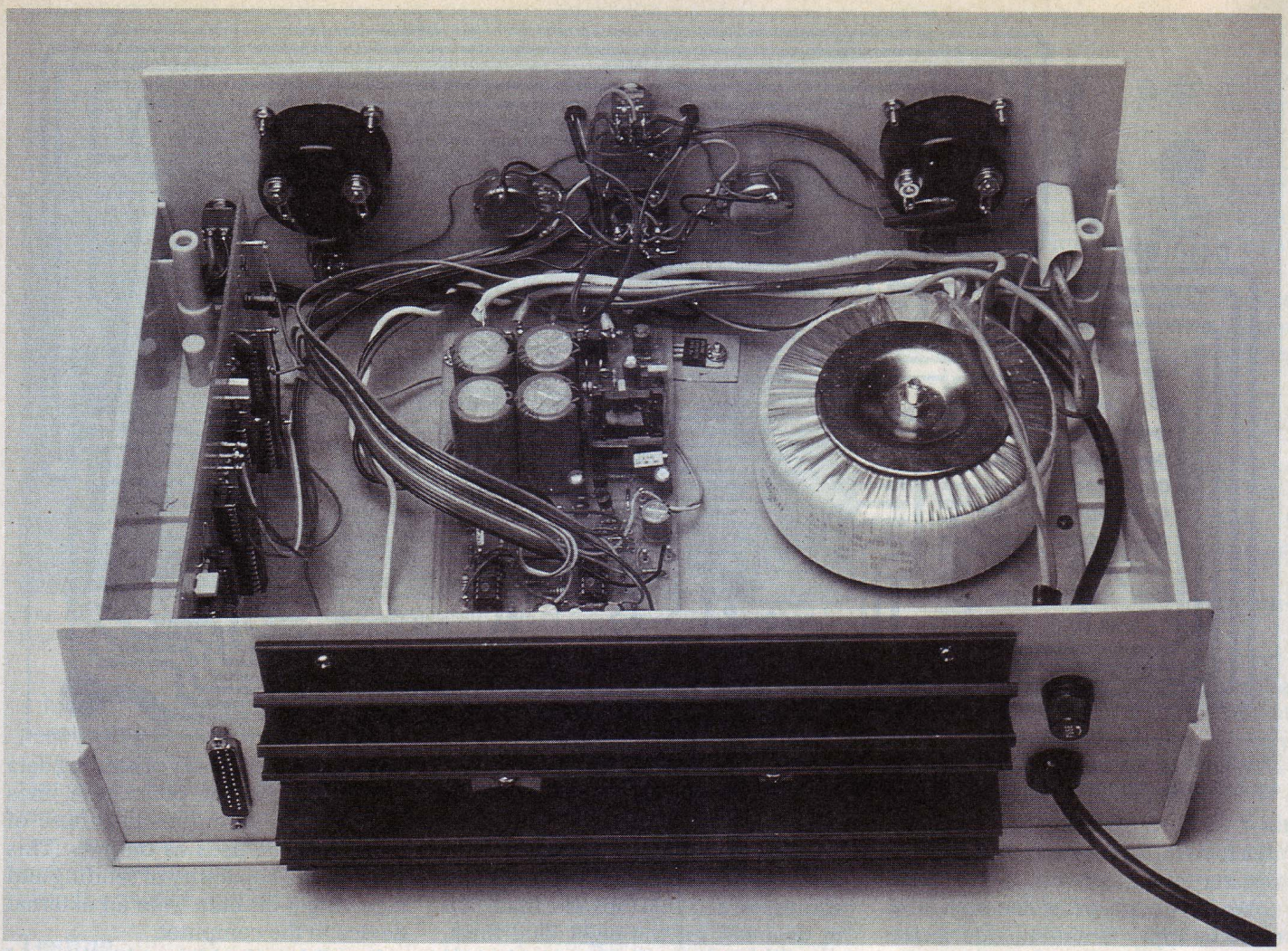
Parts List

1 PC board, code 04101972, 178 x 105mm
1 rightangle 25 pin D male connector (COON1)
4 20-pin IC sockets
3 16-pin IC sockets
1 14-pin IC socket
10 PC stakes
2 3mm x 15mm machine screws
4 3mm x 10mm machine screws
6 3mm nuts
8 3mm flat washers
6 3mm spring washers
tinned copper wire
hookup wire

Semiconductors
3 74HC573 octal latch (IC1-3)
1 74HC137 latched 1-of-8 decoder (IC4)
1 74HC14 hex Schmitt trigger (IC5)
1 74HC147 decimal-to-BCD encoder (IC6)
1 74HC4051 analog multiplexer (IC7)
1 ADC0804 analog-to-digital converter (IC8)
4 1N914 diodes (D1-D4)

Capacitors
1 100µF 16VW electrolytic
4 0.1µF MKT polyester
1 .022µF MKT polyester
1 .001µF MKT polyester
1 150pF ceramic

Resistors (0.25W, 1%)
4 1MΩ
2 47kΩ
27 20kΩ
23 10kΩ



Only a few connections need to be made from the interface board to the power supply board. The wiring diagram (Fig.2) has the details.

value which is the sum of port B and port C and gives a true value (TIN) for any data placed on these lines.

Software

The control program has been written in GW Basic, using screen 9, the highest resolution (640 x 350 pixel) colour screen. Contrary to the statement in last month's issue, the software will work with EGA and VGA monitors, not just VGA types.

The software code is quite conventional and will run in QuickBasic if lines 1-14 are removed. You will also have to create a separate program containing just lines 5100-5199 and run it to create the file before you run the main program.

Space does not allows us to present the full software listing in this article but we have included the main section from lines 20-999.

Lines 20-70, as you can see from the comments, define the functions to be used, paint the introductory screen, read the previous settings from the hard disc and give you the option of reusing them or entering new values.

Should you wish to retain an existing value, just press ENTER. The value will be accepted and the program will step to the next item. This is useful should you just wish to change the printer port for example, but retain the previous voltage settings.

The values you selected are now written to the screen (line 60) then sent to the power supply in line 70.

By structuring your program in this way you can write and debug each subroutine individually. Then if you decide to include an additional feature, it is only a matter of writing the routine, debugging it, then adding a gosub in the appropriate place.

Main program

The main program, after the initialisation and preliminary housekeeping (lines 20-70), consists of lines 80-160 which, while there is no keyboard key pressed, will run lines 100 and 110 continuously. That is, read the data from the power supply and write these values to the computer screen.

As the standard 8x14 text numerals look quite insignificant on the screen, we produced some larger, chunkier numerals using a rectangular block (CHR$219), defined on line 1260 and drawn by subroutine 4000.

Keyboard input

When a key is pressed the program branches to line 10000 which is the keyboard service subroutine. If a key which it recognises is pressed it will carry out the command and send a new value to the power supply. If a non-programmed key is pressed, it will be ignored and the program will return to running lines 100 and 110.

If you read the comments at lines 10021 to 10028 you will understand which keys do what. We used both E and V for the positive voltage and A and I for current, accepting both up-

per and lower case characters, just so you don't have to try to remember which keys to use. When you are typing the program there is no need to include the comments but if you come back to study it at a later date, they will help your understanding.

As described previously we have two functions, read from and write (send) to the power supply. We read the power supply voltages and current and write values to the D/A converters.

Writing to D/A converters

The write function is carried out by first placing the value we wish to write to a particular D/A converter on PORTA, then writing its address to PORTC. These addresses are listed in lines 1330-1400. The address for the first D/A converter ODA1 is 9. We can't call it DA1, as we have defined D as a string in line 1030.

You will notice that all the addresses are odd numbers, which indicates that the strobe line will be low (as we have explained previously, the logic for this line is inverted).

When the address is written to PORTC, pin 4 of IC4 (latch enable) will be pulled low but after a short delay will go high as the .001µF capacitor charges through the 10kΩ resistor.

The strobe is then taken high again to prevent the A/D converter being enabled (see "reading power supply values") and placing data on the PORTA bus. ODA1 is now deselected, as any changes to PORTA data would be transferred to IC1's output.

Now the data which was present on PORTA has been latched by IC1 and is available as an analog voltage at D/A1 output. The other converters are loaded in a similar manner.

When we write to the D/As we always update the three of them and this is done in subroutine 8000.

Reading power supply values

To read a value from the power supply we latch its address into IC4. This time we don't take the strobe line high as we did previously, as we want to turn on the A/D converter, IC8. After the delay introduced by the resistor and capacitor between the output of IC5a and the input of IC5f, this will be the case as its chip select (CS) will go low. This connects its tri-stated output to the PORTB and PORTC bus.

Listing 1

```
20 GOSUB 1000 'Initialise
30 GOSUB 2000 'Write screen heading
40 GOSUB 5000 'Get previous saved values from file
50 GOSUB 6000 'Write old settings to screen with option to change
60 GOSUB 7000 'Write selected data to screen
70 GOSUB 8000 'Output data to power supply
75 'MAIN PROGRAM loop 80 - 160 starts here. Monitor power supply & keyboard
80 K$ = INKEY$
90 WHILE K$ = "": K$ = INKEY$ 'While no key is pressed
100 GOSUB 9000 'Read data from PSU
110 GOSUB 7000 'Write data to screen
120 WEND 'A key has been pressed
130 GOSUB 10000 'Service keyboard
140 GOSUB 6360 'Update preset values
150 GOSUB 8000 'Write new values to power supply
160 GOTO 80 'Loop again
900 GOSUB 5100 'Save power supply settings
999 CLS: SYSTEM
```

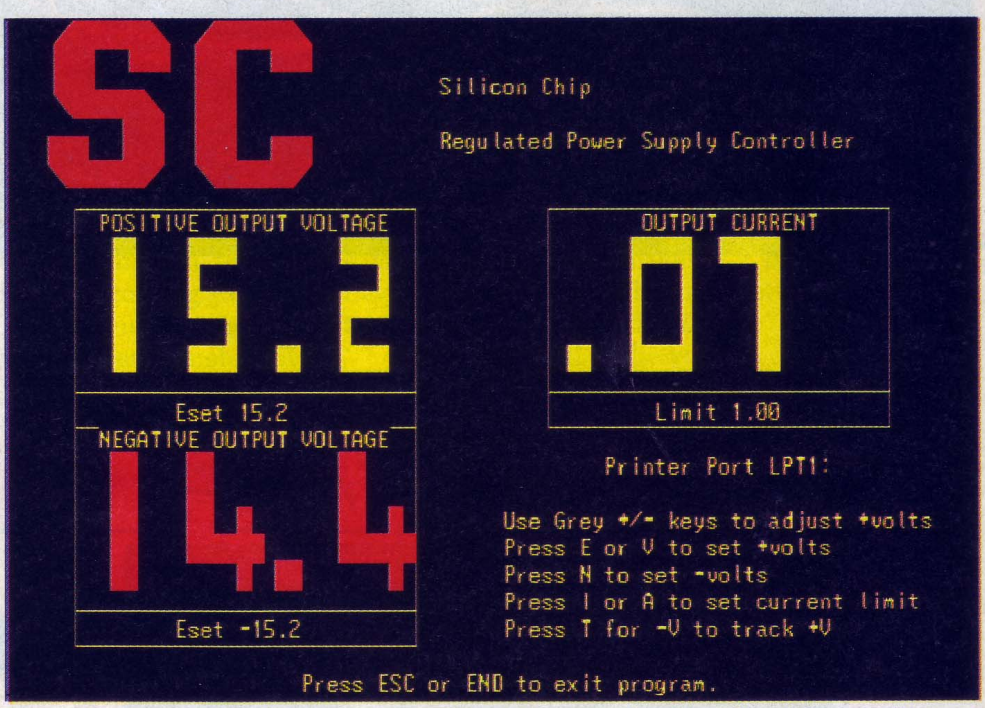
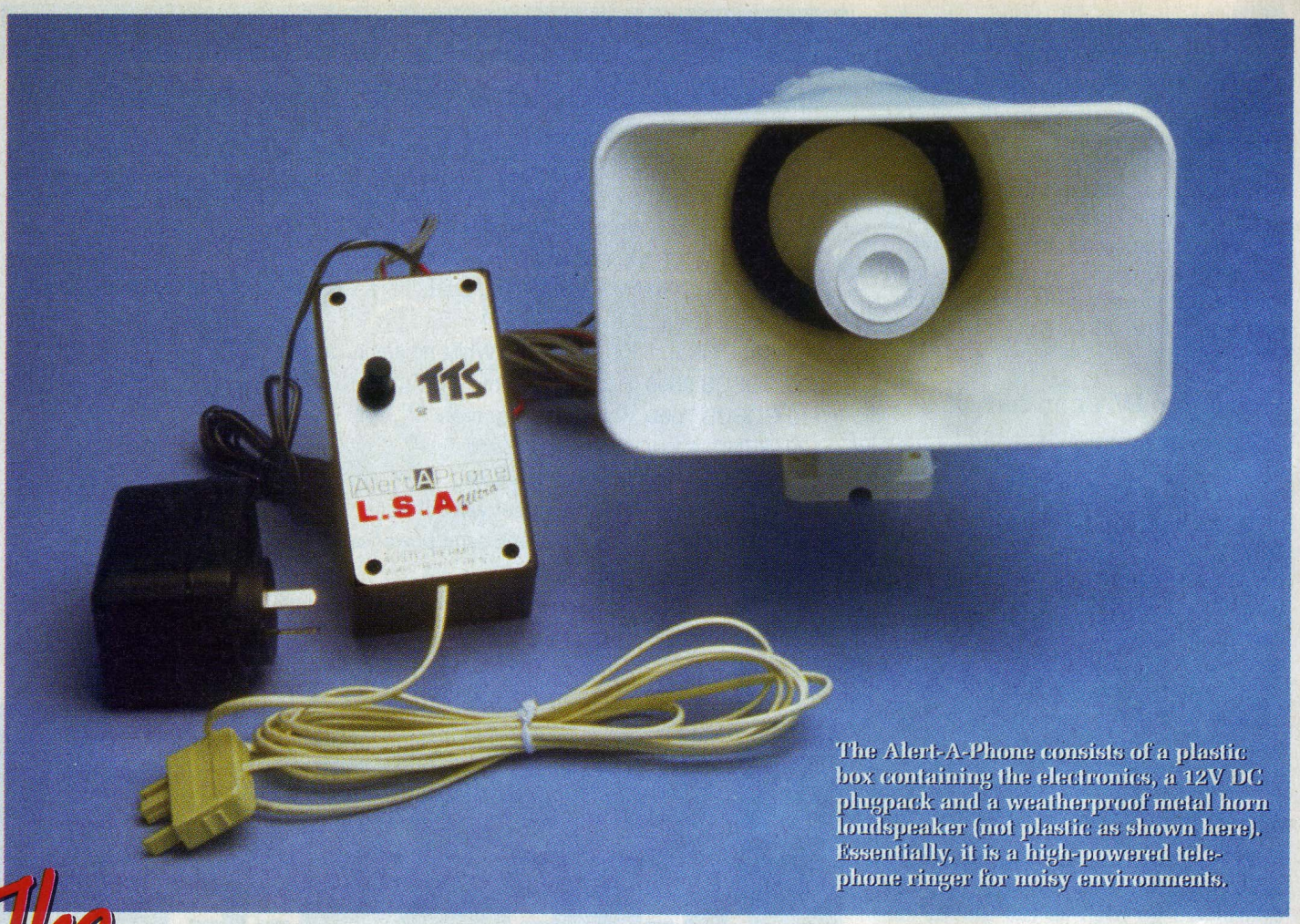


Fig.5: the positive and negative output voltages are displayed on screen, along with the output current. Also shown are the instructions for varying the output voltages and for setting the current limit and tracking.

For the PORTB and PORTC lines to be used as inputs they must all be set high. Then they will either stay high or be pulled low by the A/D. This procedure is carried out by subroutine 9000.

The last area to cover is the linearisation of the readings returned by the power supply. Lines 1420-1440 list the correction factors we found satisfactory for our supply. These are implemented in subroutine 9000 on lines 9140, 9210 and 9280. These have been REMmed out and values of 1.0 substituted in lines 1411-1413.

The procedure is to make a table of the output voltage at the terminals versus the voltage shown on the screen. You then calculate the adjustment factor to give the correct reading for each range. Once you have the values, delete lines 1411-1413, remove the REMs from lines 1420-1440 and enter your values. **SC**



The Alert-A-Phone consists of a plastic box containing the electronics, a 12V DC plugpack and a weatherproof metal horn loudspeaker (not plastic as shown here). Essentially, it is a high-powered telephone ringer for noisy environments.

The Alert-A-Phone

. . . a very loud ringer for your telephone

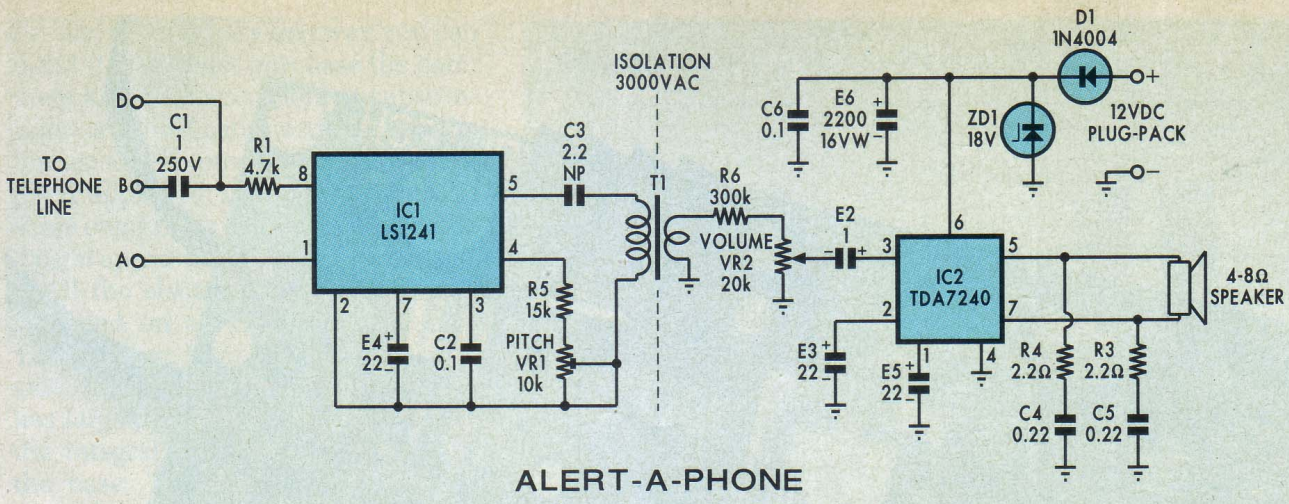
Do you work in a very noisy environment and you can't hear the phone when it rings? Or are you hard of hearing? If so, this project is for you. It is the Alert-A-Phone Loud Sounding Alarm. It connects in parallel with your existing phone and it is Austel-approved.

DESIGN By DEREK DIGGLES*

The Alert-A-Phone Loud Sounding Alarm has nothing to do with burglar alarms – a point we want to clarify right at the start. It is intended for use in noisy environments where normal phones are just about impossible to hear.

The Alert-A-Phone can be turned up to a level which is really loud; deafening, in fact. That is its main feature. The others are listed in a separate panel in this article.

As well as a weatherproof horn loudspeaker, the Alert-A-Phone com-



ALERT-A-PHONE

Fig.1: two integrated circuits are used. IC1 is for AC ring signal detection and ringer tone generation while IC2 is a 20W bridged audio power amplifier which drives the horn loudspeaker.

prises a small plastic case to house the electronics, a 12V DC plugpack and a standard phone plug with a 3-metre cord. While the phone and the Alert-A-Phone will normally be within three metres of each other, the horn loudspeaker can be up to 20 metres away and can be mounted outdoors since it is weatherproof.

Other features of note are anti-tinkle circuitry and it will work with the new distinctive ring patterns used by Telstra and Optus as well as the normal ring cadence. The ring tone is adjustable in pitch, so that more than one Alert-A-Phone can be used if required with different phone lines.

The Alert-A-Phone is housed in a plastic case measuring 128 x 42 x 65mm and this has a label on both sides. On the topside is the volume knob which is removable, to stop unwanted fiddling with the control. The label on the underside has the supplier's name, address and phone numbers: Telephone Technical Services, PO Box 357, Cleveland, Qld 4163. Phone (07) 3821 1222; fax (07) 3821 2161.

Now let us discuss the circuit which is shown in Fig.1.

Circuit description

Two integrated circuits are used, one for AC ring signal detection and ringer tone generation and the other an audio power amplifier which drives the horn loudspeaker.

IC1 is an LS1241 electronic two-tone ringer made by SGS Thomson Microelectronics. It is designed to replace the bell in telephone handsets. It is connected directly to the incoming telephone line and is powered from it.

Fig.2 shows a block diagram of the circuitry within the LS1241 chip. The chip is powered from the telephone line by virtue of the bridge rectifier connected between pins 1 & 8 and the DC filtering is provided by a 22µF capacitor connected to pin 7. The AC ring voltage is detected (ie, when the phone rings) by the internal threshold circuit and this enables the tone generator. The tone generator then provides a ring tone in the same cadence as the incoming AC ring voltage. The ring tone is adjustable in pitch by the 10kΩ potentiometer VR1.

WARNING

Operation of this device may infringe Environmental Noise Pollution Regulations and could DAMAGE HEARING if exposure is prolonged. It is the user's responsibility to control the volume and to switch off the device if necessary to conform to local environmental guide lines.

The output stage connected to pin 5 normally drives a piezoelectric transducer but in this case, as shown in Fig.1, it drives a 2.2µF capacitor in series with an isolation transformer (T1) which couples the tone ringer signal to the volume control VR2 and

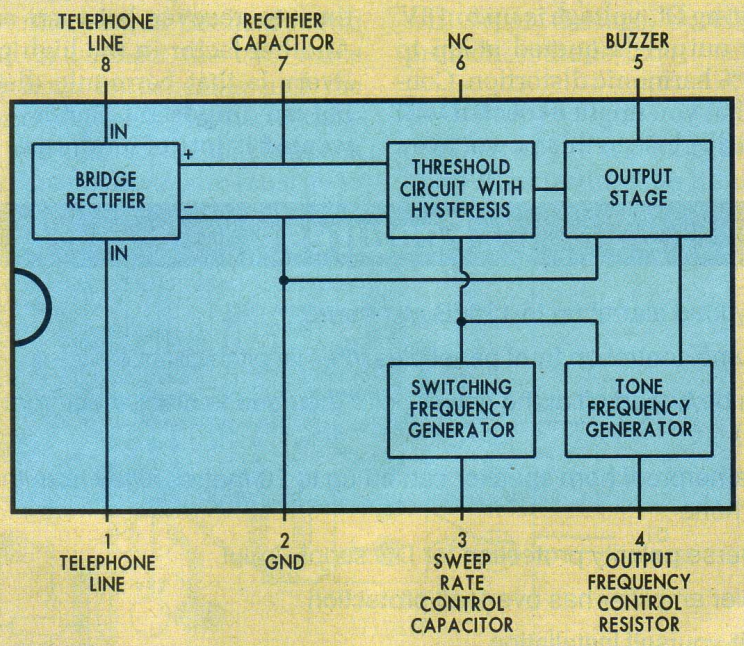
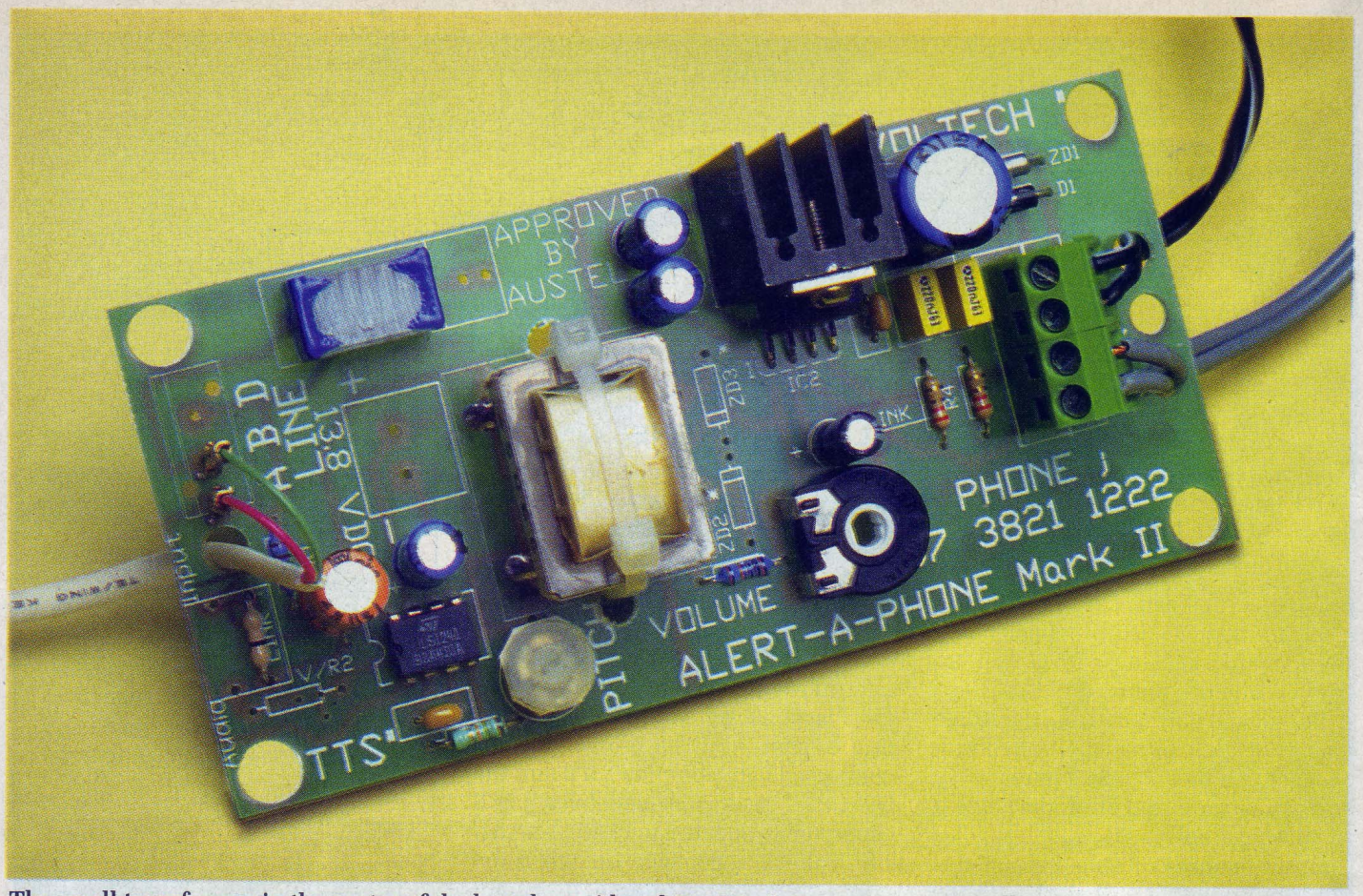


Fig.2: block diagram for the LS1241 electronic two-tone ringer. It is powered from the phone line by dint of the bridge rectifier between pins 1 & 8.



The small transformer in the centre of the board provides 3kV AC isolation between the telephone ringer IC and the bridged audio power amplifier.

the input of the power amplifier IC2.

IC2 is a TDA7240 20W bridged power amplifier normally intended for use in car radios. It is a 7-pin package with a heatsink tab. Its normal operating DC voltage is up to 18V. Its power output is quoted at up to 20W at 10% harmonic distortion. Contrary to what you might expect, it will deliver fairly close to this power even though the DC plugpack is only rated at 1A continuous; ie, 12W.

The reason it can deliver such high power is that the ring signal is intermittent, giving the supply plenty of time to recover between each ring. Another factor in the high power delivery is that harmonic distortion is not an important factor – what is wanted is lots of loudness!

Features

- ✔ Very loud alarm; up to 120dB at 1 metre
- ✔ Volume control on front panel plus internal pitch control
- ✔ Can be turned off at the power point (no need to disconnect from phone line)
- ✔ Weatherproof horn speaker can be up to 20 metres away from the Alert-A-Phone
- ✔ Reverse polarity protection for DC supply input
- ✔ Power amplifier has overload protection
- ✔ Do-it-yourself installation
- ✔ Austel approved: Permit A9601B/0017
- ✔ Ringer equivalence number REN = 1

Since the TD7240 is a bridged power amplifier, the horn loudspeaker is directly connected to pins 7 & 5; no coupling capacitor is necessary.

Zobel networks consisting of a 2.2Ω resistor and 0.22µF capacitor are connected to both outputs at pins 5 & 7 to ensure amplifier stability, especially as long output lines are being used.

Fig.3 shows the waveforms that can be expected in the circuit. The top trace (channel 1) is the incoming AC ring voltage with an amplitude of just over 200 volts peak-to-peak. The bottom trace shows the signal generated by the tone ringer measured at the output of the transformer T1 and the amplitude is around 12 volts peak-to-peak.

Note: the waveforms are taken from the screen of a Tektronix TDS 360 digital scope and because of the very low timebase speed of 0.5s/div there are symptoms of aliasing in both waveforms.

The bottom waveform is modulated in both frequency and amplitude to give the typical warbling tone of a modern telephone.

Putting it together

Since this is an Austel approved

device, there is only one way you can build it. You must purchase the complete kit and no component substitutions or modifications are allowable. It must also be powered from the supplied approved 12V DC plugpack. If these conditions are not followed, the Austel approval will be null and void.

All the electronic componentry is mounted on a PC board measuring 123 x 58mm. This board mounts upside down in the plastic case and it has large corner holes which fit over the integral corner plastic pillars in the case. This method avoids any screw heads protruding from the case which would probably not meet Austel standards.

For the same reason, the removable volume control knob and shaft is of plastic construction. Fig.4 shows the component layout on the board.

The PC board has a screen-printed component overlay on the topside and the copper pattern side has a green solder mask.

The first step is to install the resistors and the capacitors, ensuring that the four electrolytic capacitors are correctly oriented. This done, install the diodes, potentiometers and the 4-way insulated terminal block. IC1 is soldered direct to the PC board while IC2 is soldered in and fitted with a small finned heatsink which is also soldered at two points on the board.

Two spade lugs are soldered at one end of the board at points A & B for the telephone line connection. The last component to be installed is the isolating transformer. This is soldered in and secured to the board with a Nylon cable tie.

The kit will include a 3-metre phone cable with a standard phone plug at one end and two spade connectors on the other end. These are pushed onto the spade lugs on the board, after the cable has been passed through the adjacent hole.

At the other end of the board, you will need to connect the two wires from the horn loudspeaker and the two wires from the DC plugpack. Make sure that you connect the DC plugpack correctly; the positive wire must go to the positive terminal on the board, marked with a + sign on the copper pattern and on the screen-printed overlay. If you do manage to inadvertently swap the supply leads though, there will be no damage, by virtue of the protection diode D1.

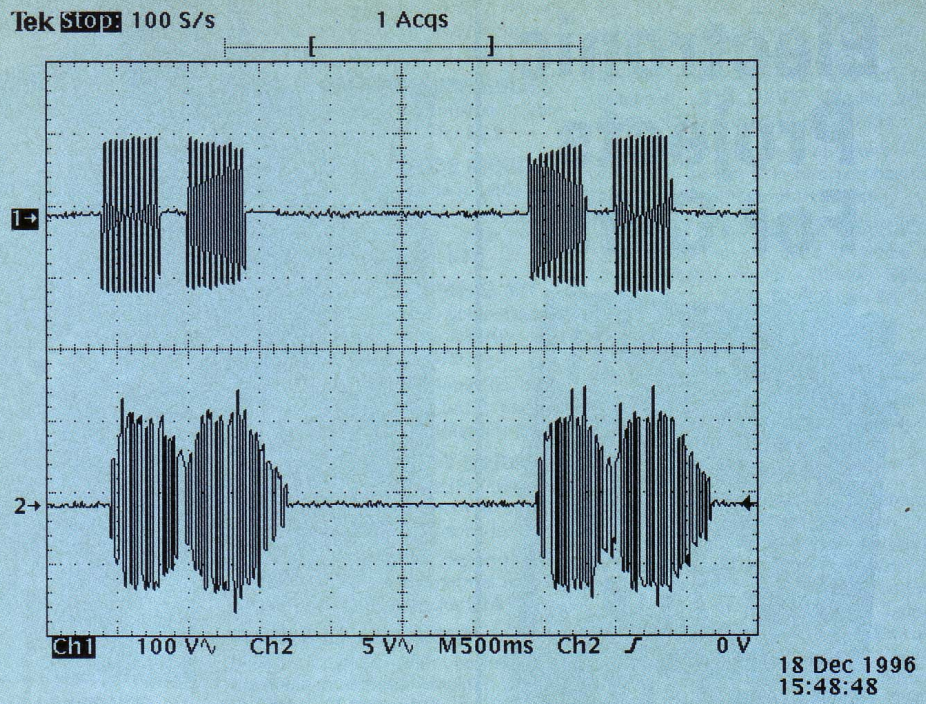


Fig.3: the waveforms that can be expected in the circuit. The top trace (channel 1) is the incoming AC ring voltage with an amplitude of just over 200 volts peak-to-peak. The bottom trace shows the signal generated by the tone ringer measured at the output of the transformer T1 and the amplitude is around 12 volts peak-to-peak. Note: the waveforms are taken from the screen of a Tektronix TDS 360 digital scope and because of the very low timebase speed of 0.5s/div there are symptoms of aliasing in both waveforms.

Initial test

When all the assembly is complete, apart from putting the lid on the box,

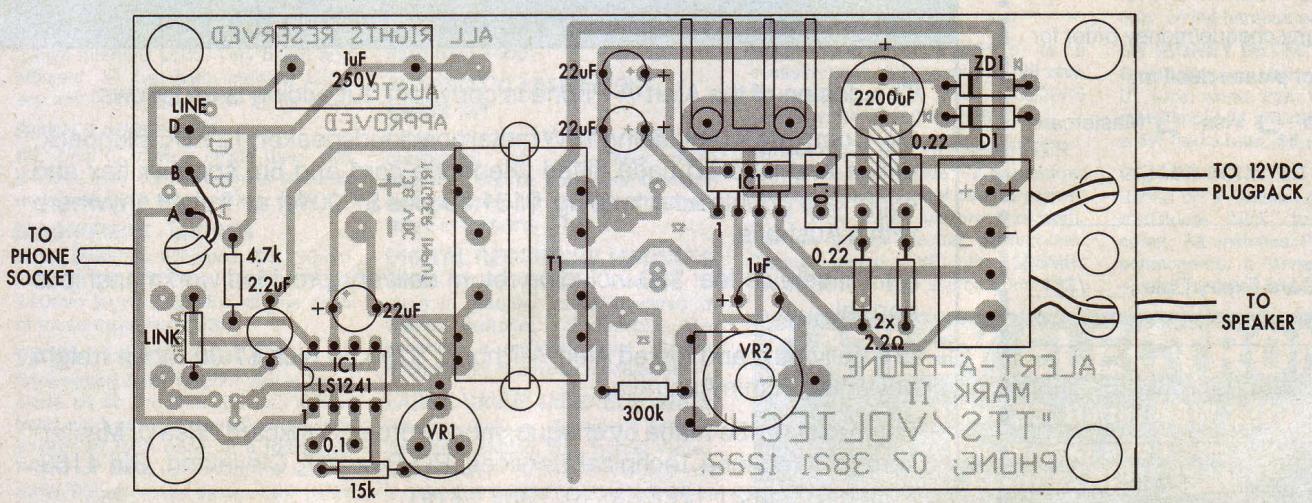


Fig.4: the component overlay for the PC board. This board mounts upside down in the plastic case.

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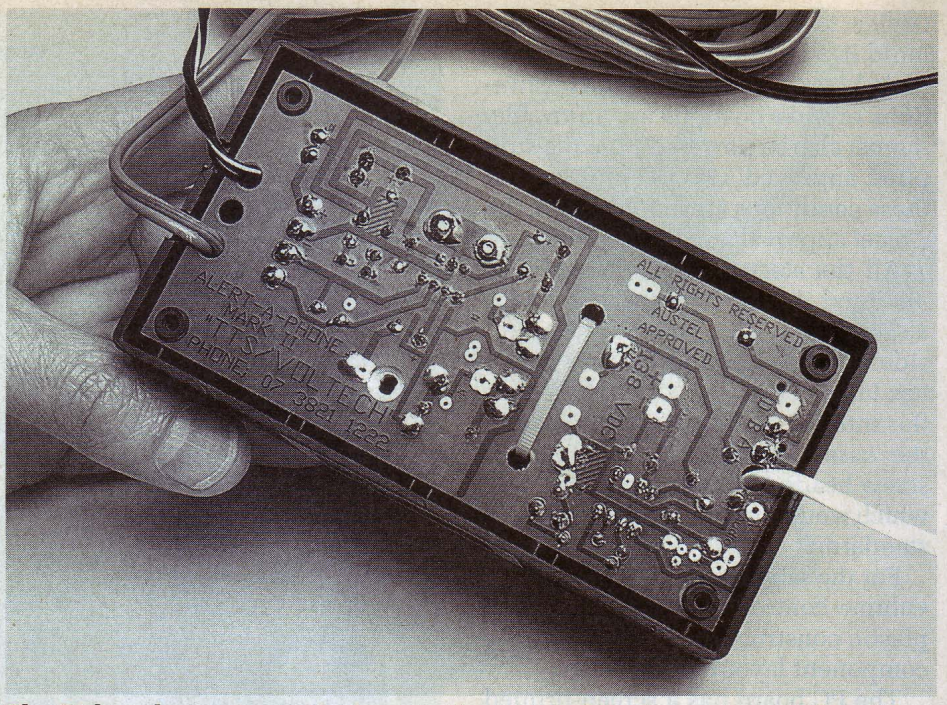

The PC board mounts upside down in the case and the large corner holes of the PC board fit over the integral pillars of the case.

initial testing can be performed, before any connection to the phone lines. Plug in the plugpack and check that you have about 14V across ZD1. Wind the volume control clockwise and put your finger on the junction of the volume control VR2 and the 300kΩ resistor. You should immediately hear a loud blurt from the speaker. If this does not occur, check all the components around IC2.

Final testing

For the final test you will need to connect the unit to the phone line, in parallel with a standard telephone. Rotate the volume control almost fully anticlockwise (minimum setting) and have someone phone in on that line (or use a cellular phone to call the line). The horn loudspeaker should ring in unison with the phone. From here, you make an adjustment to the pitch control VR1 is desired.

Finally, the unit can be permanently installed. If the horn loudspeaker is mounted outdoors, it should point downwards so that it does not catch the rain. The volume control should be adjusted for an adequate level. There is no point in having it too loud as it will only cause annoyance to people near and far. **SC**

*Derek Diggles is the principal of Telephone Technical Services.

Where To Buy The Kit

The design of the Alert-A-Phone is copyright. Kit pricing is as follows:

(1). Complete kit, including 15W metal horn loudspeaker, 12V DC plugpack, drilled and labelled case, fitted telephone cord and 5m speaker flex and telephone double adaptor plug, $131.50 plus $7.00 for air freight anywhere within Australia.

(2). Kit service fee: $30 including return delivery, provided workmanship is normal.

(3). Fully built and tested Alert-A-Phone, $193.50 plus $7.00 for air freight anywhere within Australia.

Payment may be made by cheque, money order, Bankcard, Visa or Mastercard to Telephone Technical Services, PO Box 357, Cleveland, Qld 4163. Phone (07) 3821 1222; fax (07) 3821 2161.

PIR MOVEMENT DETECTOR
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COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT
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LASER POINTERS
Two 5mW at 660nm (very bright!) laser pointers. One a small flat plastic case, the other in a small metal cylindrical case fitted with a keychain. Greatly reduced prices: **$55** ea

UV MONEY DETECTOR
Small complete unit with cold cathode UV tube, works from two AA batteries (not supplied). Inverter can dimly light a 4W fluoro tube: **$5** ea or **5 for $19**

GEIGER COUNTER KIT
Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all onboard components, a Money Detector (see above), speaker and YES, the Geiger tube is included: **$30**

PLASMA EFFECTS SPECIAL
Ref: EA Jan '94. PCB and all on-board components (flyback transformer included), and instructions: **$28** Amazing results if used with a non-functional but gassed laser tube, available for an additional **$14** if purchased with the plasma kit.

RARE EARTH MAGNETS
Very strong!!! Zinc coated. Cylindrical: 7 x 3mm, **$2** (G37) 10 x 3mm: **$4** (G38), toroidal 50mm outer, 35mm inner, 5mm thick: **$9.50** (G39)

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Kit includes a blemished fibre optic coupled IR converter tube and our night vision HT power supply kit. The tube responds to IR and visible light, and can 'see' the output of an IR remote control: **$30**

LED FLASHER KIT
3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50** ea, 10 for **$12**

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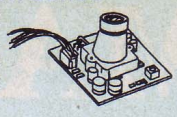
Small jewellers eyepiece: **$3**, 30mm loupe: **$8**, 75mm loupe: **$12**, 110mm loupe: **$15.** Set of one each of these magnifiers: **$30**

VISIBLE LASER DIODE KIT
Redesigned 5mW 660nm visible laser diode kit so the PCB fits into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **$85** (NEW LOW PRICING)

STEPPER MOTOR PACK
Pack of seven mixed stepper motors. Save 50%! All new: **$36**

CCD CAMERA WITH BONUS

Tiny (38x38x27mm) CCD camera, 0.l lux, IR responsive (works in total dark with IR illumination).
Connects to any standard video input or via a modulator to aerial input: **$125.**
Bonus: With each camera you can buy the following at reduced prices:
- Commercial UHF modulator for **$15** (normally $25)
- IR illuminator with 42 880nm LEDs (940nm is relatively useless) **$25** (normally $35)
- *Regulated* 10.4V plugpack for **$10** (normally $25)

WARNING
Beware of lower prices for a similar camera. You might find you have to spend several thousand dollars to qualify. As well, our price is the same for credit card purchases.
We believe our price is the lowest in the country, but phone us if you find otherwise.
Also, phone us for a special price on bulk purchases — we won't be undersold!

CAMERA - TIME LAPSE VCR RECORDING SYSTEM
Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90**

LOW COST IR ILLUMINATOR KIT
Allows a CCD camera or a night viewer to work in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs (not relatively useless 940nm): **$35**

WE HAVE MOVED
We have now moved to new premises. Our postal address is the same, but see below for our new phone and fax numbers.

ARGON-ION HEADS
Used Argon-Ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. Power supply circuit provided. Size: 35x16x16cm, weight 6.0kg. 1 year guarantee on head. Needs a 1kW transformer, available elsewhere for about $170. Argon head only: **$400**

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Small voice recording modules as used in greeting cards. Powered by watch batteries (included). Also includes a suitable mini electret microphone. 6 second module: **$9**

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Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

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Unusual lens assemblies from industrial equipment: **3** for **$22**

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US amorphous glass solar panels 305 x 228mm, Voc 18-20V, Isc 250mA: **$22** ea, 4 for **$70**
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NEW NICAD BATTERY BARGAIN
6 PACK (7.2V) of 1.2V/800mAh AA NICAD cells, plus a thermal switch: **$4** per pack (of 6) or 5 packs for **$16**
Flat rectangular (48x17x6mm) 1.2V 400mAh NICADs with thermal switch: **$4** per pack or 5 packs for **$16**

MASTHEAD AMPLIFIER
MAR-6 IC-based high performance low-noise masthead amplifier covers VHF-FM-UHF. Includes two PCBs, all on-board components and a balun former: **$15** for basic kit. Suitable plugpack: **$6** Waterproof box for masthead amplifier: **$2.50**, plastic box for combiner: **$2.50**

12V BATTERIES AND INTELLIGENT GEL CHARGERS
Intelligent 'plugpack', 240V-12V gel battery chargers, 13.8V/650mA, proper 'switching' design, with LED status indicator: **$8.80**
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FM **STEREO** transmitter, tuning range: 88 - 108MHz, supply 6-12V, current 8mA (@ 9V), PCB size 25 x 65mm. Kit includes PCB and all on-board components, 9V battery connector, and 2 electret microphones: **$25** Plastic case to suit: **$4**

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WOOFER STOPPER
Ref SC Feb '96. Kit includes PCB, all on-board components, transformer, electret microphone, one piezo speaker: **$39** Approved 12V DC 1A plugpack: **$14** *NOTE*: Works with most wildlife, including kangaroos.
Up to 3 additional piezo speakers with each kit: **$6 ea.** Previous purchasers can take advantage of this offer.

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A complete central locking kit for any vehicle. Good quality, with Mabuchi motor actuators. Can be controlled from existing UHF remote controls. Kit includes 4 actuators, control box, wiring harness, screws-nuts, other mechanical parts: **$60.** Actuators are available separately: **$9** ea

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Uses code hopping encoder and decoder ICs for ultimate security. Similar to the above system, but has built-in UHF receiver. Includes two matching 2-button UHF transmitters. One button locks, the other unlocks. Receiver has 3 relays: two for central locking and one that's activated in the lock position — for immobiliser etc. Kit also includes 4 actuators, control box, wiring harness etc: **$109**

UV MONEY DETECTOR
Small complete unit with cold cathode UV tube, works from two AA batteries (not supplied). Inverter can dimly light a 4W fluoro tube: **$5** ea or **5 for $19**

GEIGER COUNTER KIT
Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all onboard components, a Money Detector (see above), speaker and Geiger tube: **$30**

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SERVICEMAN'S LOG

Don't monkey with a VCR

VCRs can fail for all sorts of reasons but I recently had one that really takes the cake. Fortunately, not all jobs are like that one, with most being quite routine.

Just when I'd thought I'd seen everything in the servicing game, along comes something to really set me back on my heels. Spilt drinks or other liquids are common reasons for TV and VCR failures but monkey urine? – you've got to be kidding!

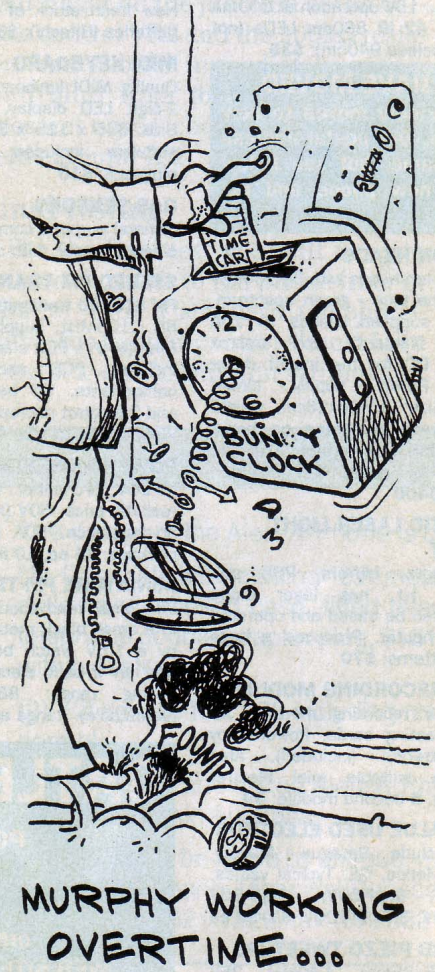
Of course, out of the thousands of servicemen in Australia, it had to be yours truly that got saddled with the job.

The story started out innocently enough. Some months ago, the local vet brought in a mid-drive Sharp VCR with the complaint that it stopped working after about two seconds on "play". The set was a 1992 VCA34X which looked to be in good condition – at least from the outside. Unfortunately, it didn't smell quite so good and had a quite distinct "pong" of stale urine about it. However, seeing that it had come from the animal surgery, I assumed that this "pong' had been picked up from something in the air.

The fault description turned out to be quite accurate and when I removed the top cover, I could see that fast forward and rewind were OK. The play mode was a different matter, however – the arms loaded the tape properly, the drum motor started and the capstan motor started but it only did a revolution or two before stopping and unloading the tape. It all looked OK, so why didn't it work?

Unfortunately, I don't have the service manual for this model but the deck was a very common type; only the electronics were different. So the first question was "is this a mechanical or an electronic problem?" I decided to inspect the whole machine carefully and turned it upside-down to remove the lower cover plate. Immediately, it was obvious from the severe corrosion where the smell was coming from. It was also obvious that this was where the problem lay.

Fairly obviously, the machine had been sitting in a pool of urine, perhaps up to 12mm deep. And although this had long been cleaned off by someone else, the corrosion was abundant to see up to the high level mark. I was about to phone the vet and tell him that all was lost and that he should get a new VCR but then I had a little think to myself.



To fix or not to fix

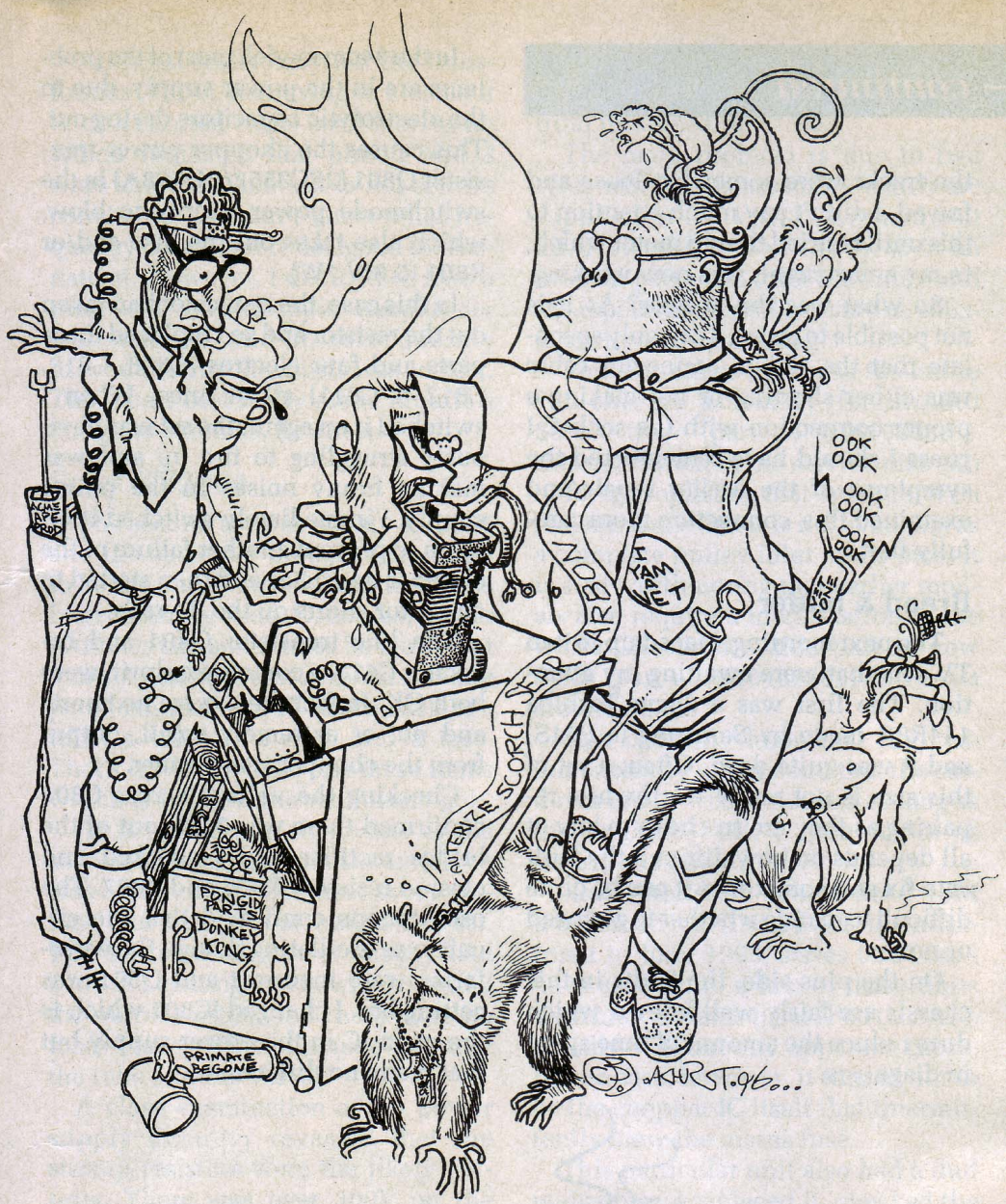
Perhaps this wasn't a hopeless case after all. First, all the major motors were actually turning and secondly, someone else had already done a pretty good job of cleaning up the mess inside. Added to that, all the bottom printed circuit boards looked OK and so I concluded that the job was worth investigating further to see if the machine could be salvaged.

At this stage, my main suspect was the drum motor as it seemed hesitant to start and its speed appeared to be intermittent when it was strobed under a neon mains light. I also discovered that, occasionally, when the video was switched from EE mode (ie, Tuner) to the Play mode, a picture could almost be seen although not always in sync.

My next step was to fire up the CRO and check the output of the PG (pulse generator) head. This revealed a pulse generator signal but it was fluctuating. Also there was 12V on pin 3 of the plug to the drum motor.

From this evidence, it seemed likely that the drum stator board or its components had corroded and so I decided to remove it to see if anything could be done. The connection to this motor is via a special 6-lead flat printed circuit ribbon cable harness whose end is just pushed into a receptacle. When I removed this, I found it to be badly corroded. I cut about 12mm off, scraped away the white varnish covering the tinned strands, cleaned the socket and reinserted the harness.

When I powered up and pressed "Play", the motor spun up quickly and continued to play correctly. I then checked the other sockets in this area but they were all OK. In hindsight, I should have suspected a cable con-



THE LOCAL VET BROUGHT IN A MID-DRIVE SHARP VCR~APPARENTLY (WOULD YOU BELIEVE?!) A MONKEY HAD AN ACCIDENT IN THAT CORNER...

nection but everything looked fine until the cable was actually removed.

I returned the video to the vet with a warning that despite cleaning it, he would probably have further problems in the long term as it is very hard to prevent a chemical reaction of this type from continuing. He apologised for the state of the VCR – apparently a monkey (would you believe it) had had an "accident" in that corner of the room and even though he had got a friend to check the VCR out, he must have missed that particular socket.

Just how long the machine will last is anybody's guess and I didn't press the vet for any further details on the monkey or what it was doing there. Let's just say that it doesn't pay to have a monkey monkeying around near a VCR.

Another Sharp VCR

I thought no more about this repair until a few months later when another similar Sharp VCR came in. This time it was a slightly older model, a VC-A105X, and the complaint was that it wouldn't play. The unit looked in good condition throughout and this time there were no unpleasant odours!

As with the previous unit, this too would load up, the drum motor would spin and the capstan motor would spin a few revolutions before it would unload and stop. This time, I did have the service manual and it also had a troubleshooting guide for the exact symptoms being experienced.

The first step is to check the head switching pulse applied to pin 3 of IC801 (IXO491) and the PG (pulse generator) signal applied to pin 4 of servo control IC701 (IX04313GE). Well, the PG pulse was there but there was definitely no head switching pulse (HSWP) . In fact, all the voltages and inputs seemed correct going into IC701 but nothing was coming out of pin 28 and there appeared to be no short circuit on that line.

In view of these symptoms, I felt that the problem had to be electronic and, at this stage, considered IC701 and/or the system control microprocessor IC801 as the main suspects. Before replacing these devices however, I first checked out all the B+ lines and the various clock signals but could find nothing wrong. The HSWP also went to the Y/C module and onto the head preamp board. I tried disconnecting these boards in turn but there was still no sign of a pulse.

With reluctance, I ordered IC701 first as I knew these ICs would be expensive. It arrived a few days later and I wasted no time in fitting it. Unfortunately, it made no difference, so that was expensive mistake number one.

I was now faced with the prospect of having to replace the main microprocessor (IC801), which was even more expensive. Before ordering it however, I tried replacing the mode select switch in case it wasn't engaging quite correctly – to no avail. Finally, I went ahead and ordered IC801. It too arrived after a couple of days and I went about the laborious task of removing the old 64-pin IC and soldering in the new one.

And that was expensive mistake number two because it also made absolutely no difference – there was still no head switching pulse. Murphy was really working overtime on this job!

A new approach

I was discussing my expensive folly with several colleagues when one said that he had recently obtained the same model as a trade-in. What's more, he offered to lend it to me so that I could pinpoint the location of the faulty parts without spending any more megabucks on useless guesses. He was also of the strong opinion that it was an intermittent capstan motor that was causing the problem as this occasion-

ally occurs on this series of decks and gives many similar symptoms.

Well, this was indeed a stroke of luck and I started by swapping over the capstan motor but that too made no difference. By now, I felt that my original diagnosis – that the fault was electronic – must be correct. As a result, I began swapping all the electronic circuitry between the two machines, board by board, but again this made no difference.

After changing the last board, I was forced to conclude that I was looking at a mechanical/motor problem. In fact, it had to be the drum motor, even though all the pulses and voltages from it were correct and it looked as though it was reaching the correct speed when viewed under the strobe light. I couldn't be certain of this, however, as it was unloading as soon as it apparently reached the correct speed. In fact, the machine did not even have time to switch from EE mode to Play mode, so no picture was available.

Anyway, I proceeded to replace the drum motor and try again. Unbelievably, it worked this time but I couldn't understand why. Out of curiosity, I measured the output from the new motor and it matched the old one exactly. How could this be? To solve this mystery, I replaced the old motor and in the process noticed that the ribbon connector cable had come away from its hardened plastic support and that the tracks were somewhat loose and frayed. I didn't pay much attention to this until I retried the old motor which, to my amazement, was now working.

So what was the answer? As it is not possible to prove, I can only speculate that the ribbon connector cable was either shorting or not making a proper connection with the socket. I guess I should have remembered the symptoms of the earlier repair and examined this connection more carefully first.

Bread & butter

The next morning, I faced up to two TV sets that were awaiting my attention. The first was a 34cm Toshiba 144R8A made by Samsung (a P54S) and it was quite dead. Often, a set of this size is not really worthwhile repairing as they are so cheap to buy. It all depends on how difficult the fault is to fix and sometimes it can be quite difficult to decide whether to go ahead or not.

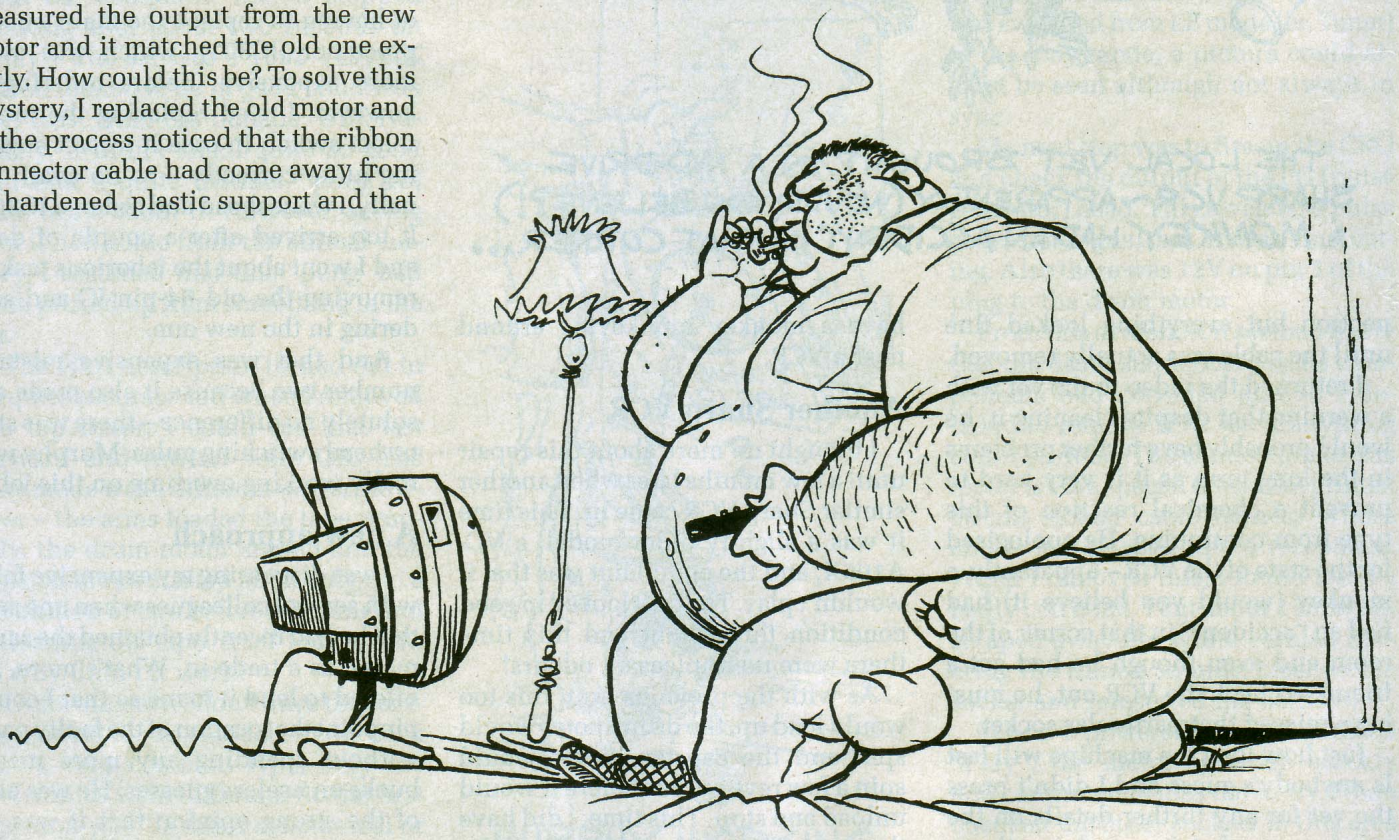
On the plus side, the faults in this chassis are fairly well known which does reduce the amount of time spent in diagnosis.

In the 34cm model, most of the problems are in the power supply, due to the electrolytic capacitors drying out. This causes the chopper power transistor Q801 (2SC3552/BU508A) in the switchmode power supply to blow, which also takes out the fuse and/or R801 (5.6W 7W).

In this case, the transistor had taken out the resistor and so I replaced these parts and four electros (C808, C813, C812 & C811) all at once. When I switched it on again, the set was obviously struggling to fire up and was making funny noises in the power supply. I immediately switched it off again to prevent another failure of the chopper transistor and then started to check for shorts on the B+ rails.

The line transistor Q404 and capacitor C413, a common culprit, were both OK. In fact there were no shorts and no, or extremely small, output from the chopper transformer.

Checking the voltage across C807 confirmed there was 340V out of the bridge rectifier and I checked and cleared resistors R806 and R807. The oscilloscope confirmed that the circuit was oscillating though the waveforms were incorrect and Q801 was getting hot. I changed IC801 which is the main IC in the power supply but that made no difference.



THE OWNER WAS A VERY HEAVY SMOKER

And that really only left the transformer (T801). Removing it, I tested it with a shorted turns oscillator/tester which indicated that pins 1 and 3 were shorted. This test is not always conclusive as I don't know what frequency the circuit is designed to resonate at. However, I decided to take a punt – a new chopper transformer was ordered and it subsequently proved that my diagnosis was correct. The repair cost really made it quite a marginal exercise, however.

Sony KV2064

The second set was a Sony KV2064 and the customer thought that it had to be the on/off switch because it was intermittently dead. Of course, power switches can sometimes be faulty but it never ceases to amaze me that many people think that a TV set consists of a tube, a valve, a switch and a fuse. That's it – it has to be one these items which is faulty if the set doesn't go!

As it turned out, the owner of the set was a very heavy smoker and there was a film of nicotine over every surface and component inside the set. The switchmode power supply had 240V AC coming into it, which cleared the on/off switch, and there were no fuses blown. This of course left only the tube and the valve!

A close examination of the power supply circuitry revealed that the startup resistors were the likely culprits. There was over 300V on the collector the chopper transistor (Q602) and the four high-value 0.5W resistors were all discoloured, although only one (R602, 330kW) was open circuit. I changed them all for high voltage types, reworked the solder just in case and switched on. It was all an anticlimax – everything worked perfectly and the set now started every time it was switched on.

All I have to do now is explain to the customer that it wasn't the on/off switch.

The reluctant NEC

Later that morning, a lady dropped in her NEC video with the symptoms that it wouldn't fast forward or rewind and turned itself off.

When I eventually got the chance to look at it, I found that there was virtually little or no take up torque, which suggested a reel idler problem. Being an N9083A, this machine was a later (1991) version of the N9000 series, with the reel drive being a sub-assembly which is fairly easy to remove from underneath.

The main problem is due to two tyres within this assembly which are supplied in the VBK83 tyre and belt kit. However, one of the tyres is an integral part of an idler assembly and the replacement will not stay on satisfactorily without gluing.

You can either purchase the entire sub-chassis assembly for around $55.00 trade (part no. 016192683 – this not shown in the service manual) or forego replacing that one tyre. It's a real nuisance that it is not available as a complete pulley idler on its own. It is also worth noting that earlier models also require a modification to the white CR slider – this part is now black (part no. 016457582) and costs around $2.00.

One can only hope that the customer clearly understood that the cut-down repair would not last as long as the original. Still, I spelt it out as clearly as I could.

This afternoon saw a dead IBM monitor arrive. It was PS/1, manufactured in June 1993, series 028-004. I have seen quite a few of these units with blown mains fuses (F601 2.5AT), usually without any apparent cause. In one case, however, it turned out to be the chopper IC itself that intermittently blew the mains fuse.

This particular unit also had a dud mains fuse. I replaced it, checked the rest of the supply for any obvious faults and then, just to be on the safe side, switched the set on with a 200W globe in series with it. Initially, the globe went bright, then dimmed and came on again at half about luminance.

The first current surge was obviously due to the degaussing circuit kicking in and there was obviously still quite a lot of current being drawn at the end of the degaussing cycle – at least 0.75A. However, the compliance plate said the full current drawn was 1.4A, so I tried it without the globe and the fuse held and the screen gave a good picture.

For the rest of the day, I cyclically switched the monitor off and on for periods of 15 minutes, without further problems. In the end, I could only advise the customer that the cause was probably either due to a mains surge or fatigue in the old fuse.

All we can do now is keep our fingers crossed. **SC**

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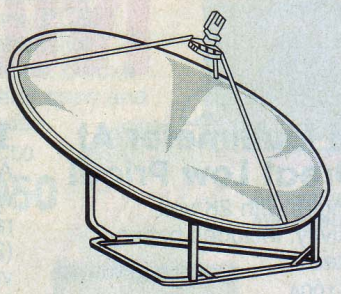

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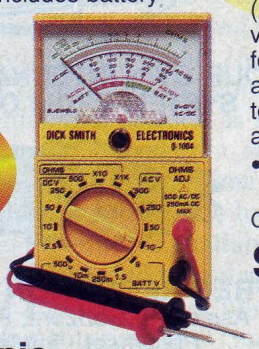

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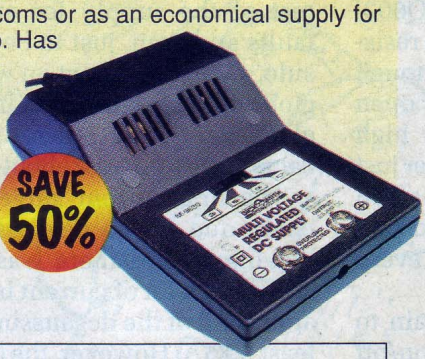

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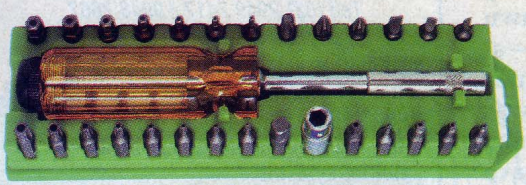

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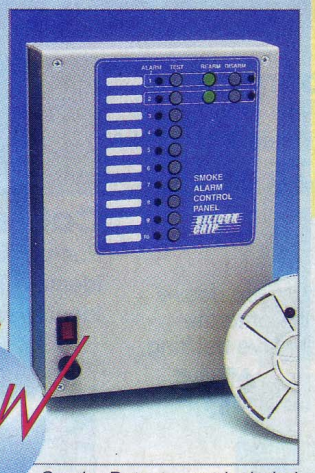

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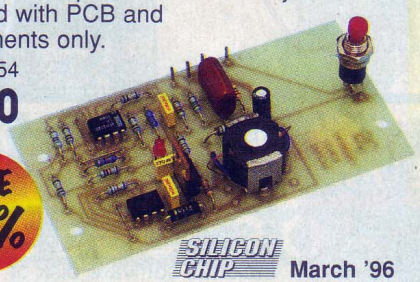

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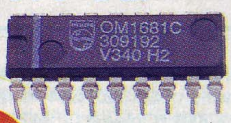

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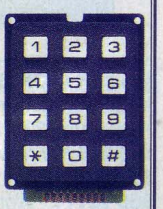

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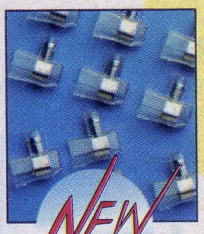

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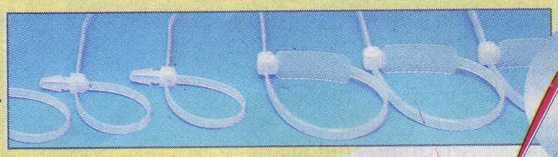

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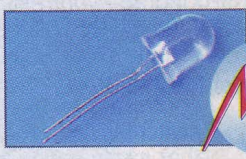

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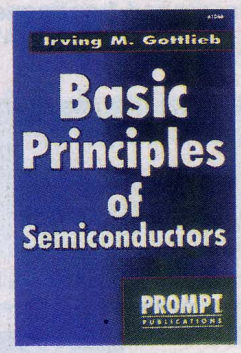

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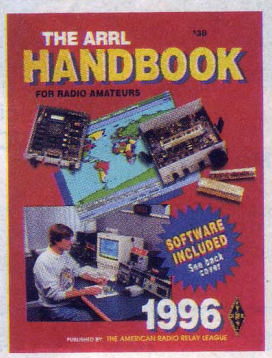

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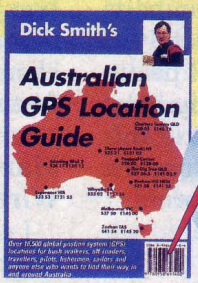

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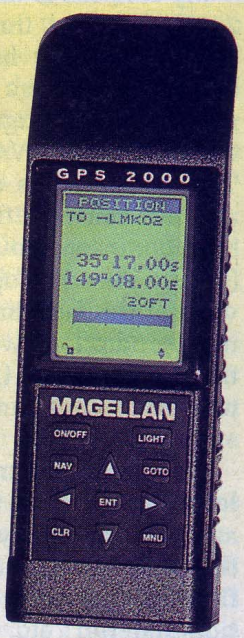

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MAILBAG

Doubts On Auto-Transformer Safety

This is a quick note to express some strong concerns with the article entitled "Stop Blowing Incandescent Lights" in the January 1997 issue of SILICON CHIP.

First up, I have to admit that I have not thought through all the electrical, insulation or failure implications of running mains through a secondary winding but initially I had the concerns with this that I did some years ago with an amplifier project in ETI which did a similar thing.

My concern is that we are running 240VAC mains through part of the transformer that has a much lower breakdown voltage than the 240V primary winding – figures of 500VAC as opposed to 4000VAC come to mind. This seems to be an enormous risk and if it caused a fire then the insurance company would be in the right (if they knew) to oppose payment in view of the fact that a non-approved non-standard use was made of an electrical component (insurance companies do this with motor car parts if it suits them).

On a more pragmatic note the heat levels at which the transformers operate are high and you are indicating that they are dependent on "free air flow unimpeded by any ceiling insulation material" etc. This is very tenuous. Let's think about possible scenarios. In my area the average length of ownership of houses is about five years.

So let's suppose the original owner puts in this arrangement for his lamps and then five years later he sells. The new owner decides, in sunny Queensland, that he will insulate the roof. Will the previous owner have passed on a "House Circuit Manual" or "List of Precautions"? Not likely!

Who will tell the contractor putting in the insulation not to cover the transformers? Will the new owner even know they are there? Not likely? Do you know with certainty how your house is done (if purchased from another party)? What if this is installed by someone in a more northern area – hotter still?

All in all, I was not impressed with the article although there was some excellent data in there about lamp life and the effects of UV etc which I am raising with our occupational health and safety staff. We have many halogen lamps in reception areas – this could be a simmering compensation issue for some time in the future!

R. Grant,
Chapel Hill, Qld.

Comment: we can address your concerns as follows. First, as we understand it, the bobbin construction of the specified transformer means that the secondary winding automatically has a high breakdown voltage. Second, the metalwork of the transformer is completely shrouded by the outer plastic housing so that even if the transformer winding did break down, there would be no hazard.

We have warned about not surrounding the transformer with insulation because it is good practice and it is required by wiring standards in any case. Household wiring should not be covered by insulation and all electricians and insulation contractors should be aware of this.

In any case, the specified transformer does have an integral thermal overload cutout and so if the transformer did overheat, it would cut out. If used as described in the article, the transformer will be running within its ratings and therefore should never be an issue in the event of an insurance claim. Indeed, we think there is a higher chance of fire from halogen light fittings themselves; they get extremely hot and again, should never be covered by ceiling insulation; nor should any flush-mount ceiling light fitting.

As a final note, we consulted with the manufacturers of the transformer, Atco Controls Pty Ltd, to ensure that there were no problems with this mode of operation.

Your comment about Occupational Health & Safety is interesting. We think that the UV output of the mercury discharge lamps used in many sporting complexes is particularly dangerous. It can cause "sunburn" after a few hours and could be a compensation issue at some time in the future. In our opinion, such lamp fittings should have a UV filter as a standard feature.

Marconi School of Wireless Reunion

I am writing for your assistance in organising a reunion of ex-Marconi School of Wireless students to be held in Sydney some time next year. The school closed in 1981 and with it into retirement went Ces Bardwell who joined the school as an instructor in 1939. Ces became principal/manager, I believe in 1949, and held that position until the school closed in 1981.

Ces will be 80 next year and he will be guest of honour at this reunion. My task is to find out where all the "ex" Marconi students and instructors are today and ask them to express an interest in attending this function.

Information required from those interested in attending this function should include the year/years of attendance and whether full-time or part-time. I can be contacted as follows: fax (make attention to "David Hawksworth") 044 210032 or email techfm@peg.apc.org

David Hawksworth,
84 Duncan St,
Vincentia, NSW 2540.

Further Advice On Networking Computers

Early in 1996 I networked a Pentium 166 and an old 486 almost identically to the method you described in the January 1997 edition of SILICON CHIP. My experience, at least initially, was not quite as straightforward as laid out in your article. When I set up my network system, I was not aware that both systems require the same "protocol" to communicate with each other.

Win 3.11 defaults to NetBEUI while Win95 defaults to TCP/IP. Initially, NetBEUI was not installed in the Con-

trol Panel/Network/Configuration of my Win95 system. After some weeks of trial and error (mostly error) I installed (added) the NetBEUI protocol to my Win95 setup. The network was then up and running within 15 minutes.

The above may be of some help to your readers if they have similar problems. The article itself was very well done and is a very useful and practical demonstration of what can be achieved with surplus equipment.

Peter Lynch,
Bayshore Park, Singapore.

Windows Dual-Boot Success

I had refused to have anything to do with Windows 95, as I dreaded having to learn another new system, until I read the "dual boot" article in the July 1996 issue of SILICON CHIP. I thought that was just what I wanted. It would allow me to continue working with my current programs under Windows 3.1 but to have a peek at Windows 95 every now and then to see what it has to offer and to learn how to use it.

So I bought a "95" upgrade and a 1.2Gb hard drive and installed it according to the article. As time went on my peeks at "95" became longer until I am now transferring most of my programs over to it. What I would like to know now is, how can I make my "95" D: drive a self-booting C: drive? Is it just a matter of transferring the Autoexec.xxx and Config.xxx files across?

For many years now I have been trading in my car on a new one about every four years. I did this so as to reduce the chance of being held up in the "sticks" by a major breakdown. But I had always been dubious about electronic fuel injection and shied away from cars fitted with it. As electronics is my trade I know how delicate electronic equipment can be and I was always concerned about it breaking down in an EFI car while out in the bush somewhere.

Then I read your excellent series on Electronic Engine Management and learnt that EFI is fairly reliable after all and that if it did break down, it wouldn't disable the car completely and leave you stuck in the wilderness. So my last new car was one fitted with EFI. It seemed to perform quite well. The thing I liked about it was how it started the same, hot or cold.

But my new car did break down! With a broken timing belt! At 7000km! Luckily, I was able to call for assistance with my CB radio and catch a bus home. Three days later I was on the road again and haven't had any more problems. The warranty has just expired. So it just goes to show, you don't know what's going to happen. A timing belt can go at any time in any vehicle and here I was concerned all the time with the EFI.

Keep up the good work with your magazine.

T. Vieritz,
Emerald, Qld.

Comment: unfortunately, there is no easy way to make your Windows 95 D: drive into a self-booting C: drive. The only foolproof way is to reformat the drive, reconfigure your hardware setup as necessary, and then load everything back on in the way you want it. We suggest you wait until you are sure that you can do without Windows 3.1 and then make a complete change to Windows 95.

Your comments about vehicle electronics are interesting. Apparently, by far the most common cause of modern car breakdowns is a flat battery.

Power Supply Weakness For Smoke Alarm Control Panel

I have just read the article on the Control Panel for Multiple Smoke Alarms in the January 1997 issue of SILICON CHIP. I feel this is a most dangerous project, due to the fact that the loss of the 9V supply, due to a short anywhere in the field, completely shuts down the whole system. That is the reason that the 240VAC units require a 9V battery backup for mains loss, so detectors can still work.

L. Hirning,
Dee Why, NSW.

Comment: while we agree that the loss of the 9V supply would disable the whole system, there is a visible indicator in every smoke alarm to tell you that it is being monitored. If you can't see it flashing, you know it is dead. The same criticism could be applied to every burglar alarm – if the main supply is lost, the alarm is dead but again, there is visible monitoring.

Our approach to the Smoke Alarm Control Panel is essentially the same as in large building installations where the individual alarms usually are all connected to an RS232 line and have their own unique addresses and no backup batteries. Again, each detector has a visible LED indicator to show that it is being monitored.

Flashing Lights Foil Hunting Cats

In your response to a letter from K.F., of Albion Park Rail, on page 93 of your August 1996 edition, headed "Cat deterrent not humane", you invite comment.

It was an interesting and perceptive observation that you made in reply to the reader's suggestion that emitted sonics would not deter birds in preference to bells attached to cats' collars. We are given to believe by the avian experts that sonics do not indeed have any deterrent effect on birds.

Your thoughts that cats should not be let out at night are not without precedence. In Victoria, there is a curfew placed upon them in cities and shires that have elected to enforce, what is now state law, and bird and reptile population is now on the increase in those areas.

Because cats hunt, by preference during the hours of sunset to sunrise, so we have researched and developed a tiny battery driven unit which emits high intensity flashing light from a position behind the cat's neck. It can thus be used by responsible cat owners as a "Skare" for birds and other creatures.

The cat is unaware of this and the "Skare" acts as a far more effective deterrent than tinkling bells but has added safety benefits for the cat in that it is illuminated if crossing roads in unlit areas.

This device will shortly be marketed through our existing "K-9 Collar" outlets whose primary purpose is the humane and safe containment of dogs, by proven methods using sonics and avoidance therapy.

John Foley,
Canine Invisible Enclosures (Qld) Pty Ltd, Tugun, Qld.

Build this low cost

ANALOG MULTIM

Are you in the market for a low cost analog multimeter? They do have their uses in spite of the fact that digital multimeters have taken over. So why not put this kit meter together? You'll learn about multimeters in the process of assembling it.

By LEO SIMPSON

You wouldn't build this little multimeter to save money although it is pretty cheap. No, the reason for building it would be to gain a little experience in kit construction and to learn about analog multimeters. We foresee that large numbers of these meters will be built as part of school and TAFE college courses. That is what happened with the last analog multimeter we described, in the November 1989 issue of SILICON CHIP.

And even though we're quite sure that virtually every reader of this magazine has a digital multimeter, there are times when an analog meter is more suitable than a digital type. This is especially the case when the reading you are taking is fluctuating. When this happens it is not easy to make any sense of rapidly changing readings on a DMM (digital multimeter) but the movement of the pointer on the analog meter will give you a clear picture of what is happening.

Two examples of measurements where the reading can fluctuate will demonstrate the point. The first is when you are carrying out an alignment procedure on a radio – the analog meter allows you to easily tweak the coil slugs for a peak reading.

The second is when you are using the "Ohms" range of a multimeter to judge the leakage of a capacitor, particularly an electrolytic type. Judging by the speed with which the pointer moves up the scale, you can tell whether the capacitor is good or bad, especially if you have a known good capacitor to make a comparison.

One other really good point about an analog meter is that its battery does not go flat at the most inconvenient time – when you want to use it, of course. How often

ETER

have you dragged out your digital meter only to find that it has gone off duty because its battery is flat.

This happens quite often with the cheaper DMMs because they are a bit hungry on batteries. By contrast, while all analog multimeters have a 1.5V cell and possibly a 9V battery to run the Ohms ranges, it very seldom goes flat and anyhow, you can still make voltage and current measurements even if the battery is completely dead.

No off switch

As part of this battery eating concern, you never have to worry about turning an analog meter off. Just leave it as you last used it and it will sit there contentedly, not using any battery power at all. Unless your DMM has an "auto-off" function, you can't say that about a digital meter.

So while analog meters have been superseded by digital multimeters for most work, they are still handy to have.

Multimeter features

The meter in question is quite a good size and measures 148 x 99 x 34mm thick. This means that the scales are reasonably large and easy to read – an important point with an analog meter. This one has no less than eight scales on the meter face.

The meter movement has the standard DC sensitivity of 20,000 ohms/volt on DC ranges. What this means is that it will draw 50 microamps from the circuit being measured, for a full scale deflection (FSD) of the pointer. When measuring voltages in high impedance circuits it is most important to take this loading effect into account, otherwise the readings will be very misleading.

Most of the relevant multimeter functions are listed in the accompa-

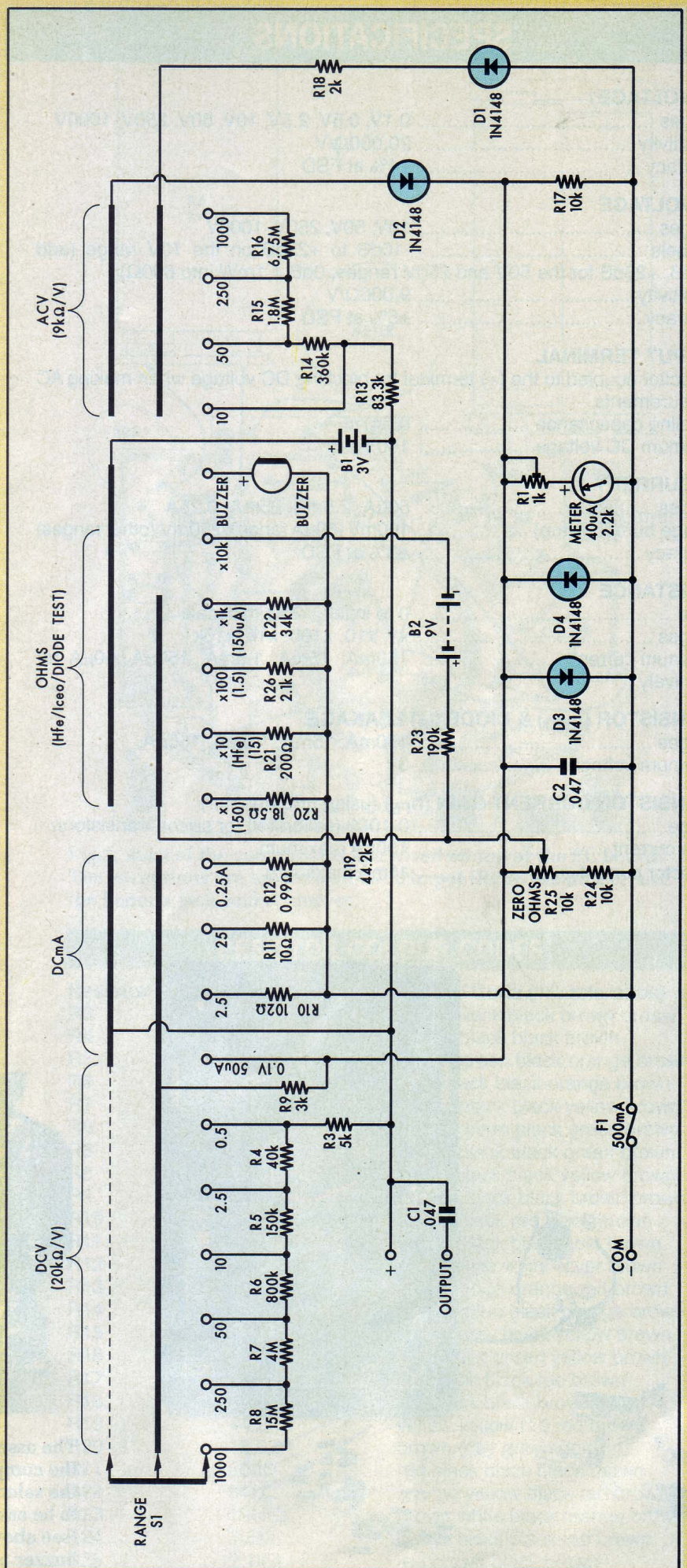


Fig.1: the circuit of this analog meter is passive; ie, there are no active devices to amplify signals. The four diodes are the only semiconductors. D1 & D2 enable the meter to read AC voltages and currents. D3 & D4 are there to prevent damage to the meter movement in the case of a severe overload. All the switch contacts and tracks are integrated into the pattern of the PC board.

SPECIFICATIONS

DC VOLTAGE
Ranges 0.1V, 0.5V, 2.5V, 10V, 50V, 250V, 1000V
Sensitivity 20,000Ω/V
Accuracy ..... ±4% at FSD

AC VOLTAGE
Ranges 10V, 50V, 250V, 1000V
Decibels ..... -10dB to +22dB on the 10V range (add +14dB, +28dB for the 50V and 250V ranges; 0dB = 1mW into 600Ω)
Sensitivity 9,000Ω/V
Accuracy ..... ±5% at FSD

OUTPUT TERMINAL
Capacitor coupled to the (+) terminal for blocking DC voltage when making AC measurements
Coupling capacitance 0.047µF
Maximum DC voltage 100V

DC CURRENT
Ranges 50µA, 2.5mA, 25mA, 0.25A
Voltage burden (drop) ..... 100mV (50µA range), 250mV (other ranges)
Accuracy ..... ±3% at FSD

RESISTANCE
Scale ..... 0 to infinity, 20Ω midscale
Ranges x1, x10, x100, x1k, x10k
Maximum current ..... 150mA, 15mA, 1.5mA, 150µA, 60µA respectively

TRANSISTOR (I_{CEO}) & DIODE (I_R) LEAKAGE
Ranges 150mA, 15mA, 1.5mA, 150µA
Maximum voltage 3V

TRANSISTOR CURRENT GAIN (h_{FE}) (using hFE adapter)
Range ..... 0-1000 (calibrated for silicon transistors)
Base current ..... 100µA maximum
Collector current ..... 11mA maximum

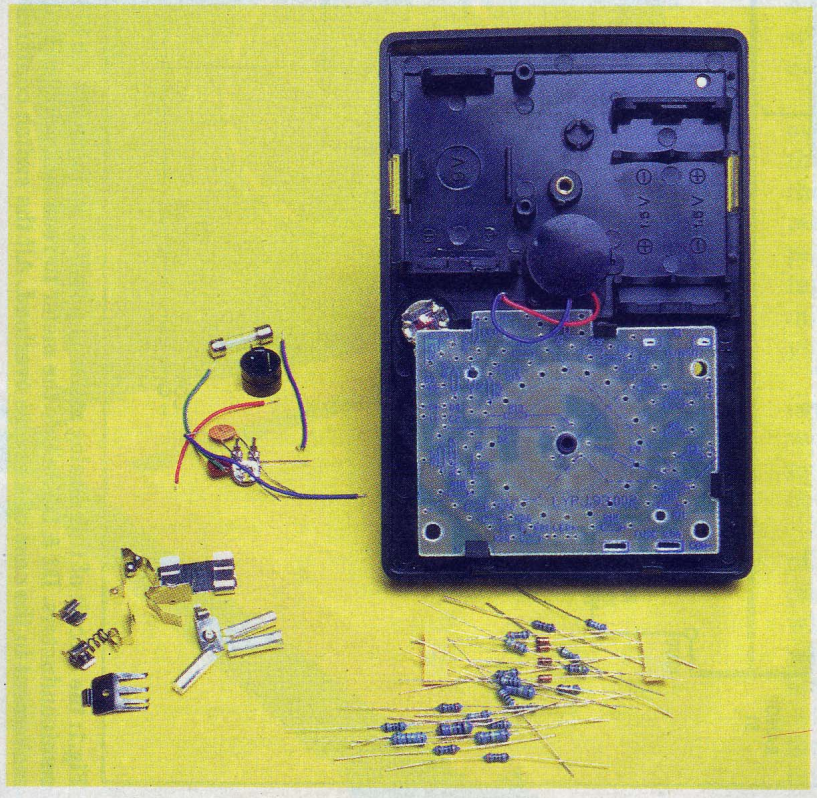
nying specifications panel. The circuit is shown in Fig.1 and is fairly conventional as analog multimeters go. The multi-position range switch controls all functions, switching multiplier resistors in and out for the various ranges.

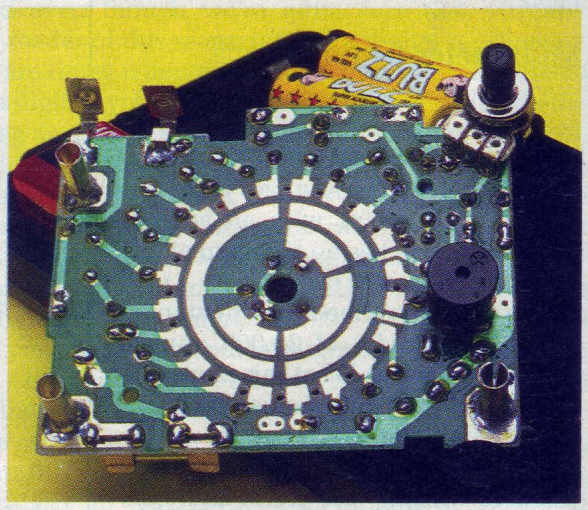
Note the diode protection of the meter movement, with D3 and D4. These prevents the meter movement from being mechanically damaged or burnt out if it is connected to an excessive voltage while switched to a low voltage or low current range. However, if an overload does occur the meter's pointer will still slam hard against the stops and the relevant range multiplier resistor may be burnt out. Oh, and the fuse may blow as well.

Output terminal

Some readers may be unfamiliar with the function of the OUTPUT terminal which is connected to the positive input connection via C1, a .047µF 100V capacitor. This has nothing to do with an output from the meter but is a traditional feature on analog multimeters, harking back to the days of valve amplifiers. It enables you to measure AC voltages at the plates of valve stages. The capacitor is there to block DC voltage while allowing the AC voltage to be measured.

While the traditional feature is fine, it could be a trap for young players on this meter, if they do attempt to measure AC signal voltages in a valve amplifier. For a start, the voltage rating of





The assembly work mainly consists of soldering the components onto the PC board and putting the selector switch together. The only components to be assembled on the copper side of the board (see above) are the zero adjust trimpot (R25), the buzzer and the banana jack socket sleeves.

the capacitor is much too low for such measurements. We would prefer to see the capacitor rated for at least 600V DC. The only problem is that such a capacitor would not fit in the available space.

Analog meter construction

When you open the kit, you will find a number of small plastic bags as well as the meter case with the meter movement already installed.

Fig.2 shows the component overlay for the PC board and the wiring inside the case. This diagram shows the component values while the PC board is screen printed with component numbers; eg, R1, R2 etc. When you install each component make sure that its value on the circuit is matched with the component number on the PC board.

There are quite a few steps in the assembly, as follows:

(1). Solder all resistors to the main board. Check the colour codes against the list or check the values with a digital multimeter. Note: place a link across one of the two positions marked R8, if only one resistor for R8 (ie, 15MΩ) is supplied or you may be supplied with one 10MΩ and one 5MΩ for the two R8 positions.

(2). Solder all diodes into place.

(3). Solder C1 & C2 in place.

(4). Solder all precut wire links into place. Follow the dotted lines on the overlay diagram for their positioning.

(5). Solder trimpot R1 into place. The circuit shows 1kΩ but the supplied value is likely to be 680Ω.

(6). Solder the buzzer onto the copper side of the PC board. Space the buzzer 3mm above the PC board so that its leads can be soldered. Space the leads so that the body of the buzzer is flush with the edge of the PC board.

(7). Solder the "zero adjust" potentiometer R25 in place on the copper side of the board.

(8). Solder the fuse clips to the board and then fit the 500mA fuse.

(9). Insert the 'B1' battery terminals into the PC board and solder. Note; they are inserted from the copper side of PC board.

(10). Insert the three banana socket sleeves into the copper side of the PC board and solder evenly around each one. Each sleeve will sit flush with the top of the PC board.

(11). Now we are ready to assemble the rotary switch. First, take the rotary

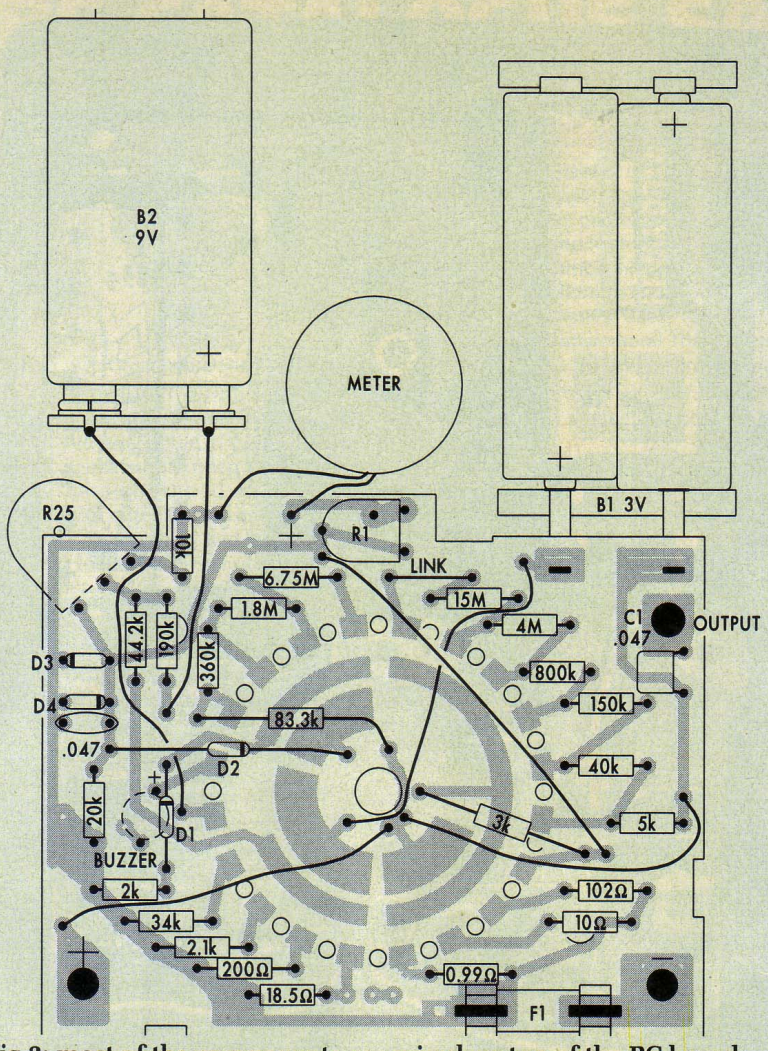
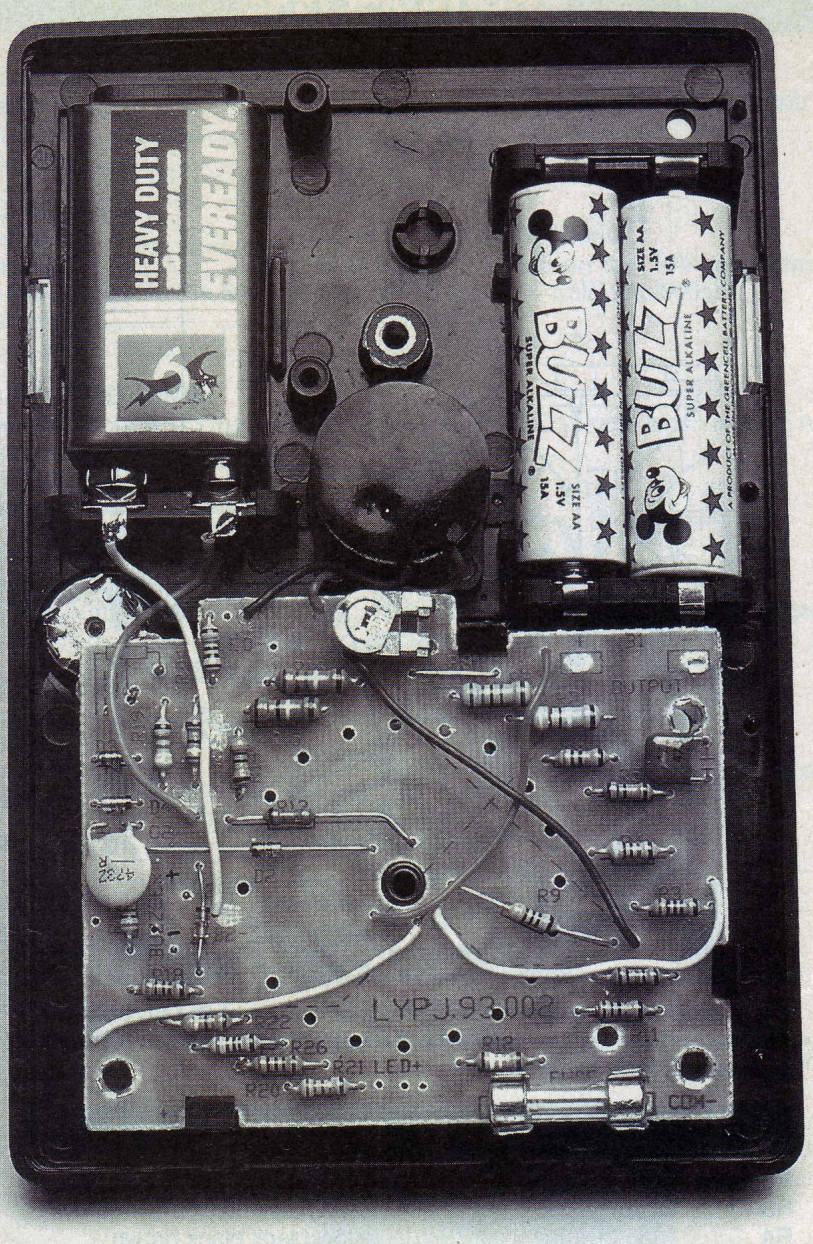


Fig.2: most of the components are wired on top of the PC board. The exceptions are the zero adjust trimpot (R25), the buzzer and the banana jack socket sleeves.

RESISTOR COLOUR CODES

Resistor	Value	5-Band Code (1% tolerance)
R3	5kΩ	green black black brown brown
R4	40kΩ	yellow black black brown
R5	150kΩ	brown green black orange brown
R6	800kΩ	grey black black orange brown
R7	4MΩ	yellow black black yellow brown
R8	15MΩ	brown green black green brown
R8	10MΩ	brown black black green brown
R8	5MΩ	green black black yellow brown
R9	3kΩ	orange black black brown brown
R10	102Ω	brown black red black brown
R11	10Ω	brown black black gold brown
R12	0.99Ω	black white white silver brown
R13	83.3kΩ	grey orange orange red brown
R14	360kΩ	orange blue black orange brown
R15	1.8MΩ	brown grey black yellow brown
R16	6.75MΩ	blue violet green yellow brown
R17	20kΩ	red black black red brown
R18	2kΩ	red black black brown brown
R19	44.2kΩ	yellow yellow red red brown
R20	18.5Ω	brown grey green gold
R21	200Ω	red black black black brown
R22	34kΩ	orange yellow black red brown
R23	190kΩ	brown white black orange brown
R24	10kΩ	brown black black red brown
R26	2.1kΩ	red brown black brown



The finished PC board clips into the back of the meter case. As can be seen, most of the components are multiplier resistors for the various ranges.

knob and make sure it fits onto the selector plate. Make sure that, when pushing the knob onto the selector shaft, the keyway on the shaft lines up with the knob.

Next, insert a small spring into the hole located on the side of the selector plate. Smear a little petroleum jelly (Vaseline) around the selector housing where the ball bearing will run and place a dab into the end of the spring. This done, place the selector plate into the case housing and push the spring with its accompanying ball bearing into position.

Now turn the meter over, at the same time applying pressure to the selector plate so that it doesn't pop out. Line up the selector knob keyway and from the front of the meter, push the knob into place.

(12). Position the rotary wiper on the selector plate, with the integral plastic pillar locating the metal tab. Use a hot soldering iron to melt the top of the plastic pillar so that the wiper is permanently fixed in place.

(13). Solder the meter wires to the PC board (note polarity).

(14). Solder the 9V battery terminal wires to the PC board (points B2+ and B2-; note the polarity).

(15). Before clipping the PC board into position, clean and polish the circular tracks of the selector switch. Methylated spirits will help dissolve any flux residues from soldering.

(16). Insert the batteries into their respective holders. Fit the back of the meter case and its retaining screw; do not overtighten it. Finally, fit the knob for the zero adjust trimpot (R25).

Congratulations, you have finished the assembly. There's one more step before you can make measurements.

Zeroing the meter

Before doing any measurements, always check that the meter pointer is on zero at the left end of the scale:

(1). Put the meter in the position that it will be in when measurements are made; ie, normally horizontal.

(2). Remove the leads from the meter and check that the pointer is not being deflected by stray electromagnetic fields.

(3). If the pointer is not on zero then rotate the slotted plastic 'screw' near the pivot axis of the pointer.

(5). Give the meter a light tap on the side to ensure that the pointer has settled properly.

Now you are ready to make measurements. **SC**

Where To Buy The Kit

The kit for this multimeter is available from all Dick Smith Electronics stores for $29.50. (Cat K-1050).

MULTIMETER SAFETY WARNING

- This meter must not be connected to high energy sources which have transient voltages greater than 1000V. This includes the 240VAC mains.
- Do not connect the meter to a circuit which is greater than 1000V peak above ground.
- Do not use the meter if it is damaged.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Select the proper function and range for your measurement.
- Do not change ranges while the meter is connected to live circuits.

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRON

FEBRUARY PRE CATALOGUE SALE

JC 30 COMPACT SPEAKER KIT

NEW

REFER EA FEB. 97

Crossovers shown are representative only

This speaker kit came about because we purchased a quantity of high quality cabinets from a woodwork factory who had made them for a speaker manufacturer who went broke. We purchased the cabinets at a fraction of their build cost and designed the speaker kit around them. The cabinets are extremely high quality. They are made from 19mm MDF board which is covered in an unfinished real wood veneer and needs to be stained and/or lacquered. There is a small amount of construction work required to complete the cabinets and this is reflected in the low price of the kit. Specifically this work is: rear port hole needs to be slightly enlarged, speaker grills need to be built from 4 pieces of pre cut hardwood beading supplied and grill cloth needs mounting. These jobs should not pose much of a problem to those with a modest level of woodworking skills. The fundamental quality of the enclosures will make the effort worthwhile. There are two choices of cabinet wood finishes available - Jarrah (dark) and Blackwood (light). We have a much larger quantity of Jarrah finish available. We reserve the right to to supply Jarrah when the Blackwood stocks are exhausted. THE SPEAKER KIT - the woofer used are our Re/Sponse Carbon Fibre Drivers and the tweeters are Vifa D19. The crossovers are pre built. The total impedence is 4Ω, which is not a problem for most amplifiers and they could even be used in a car stereo system. Power handling is 80WRMS.

SPEAKER KIT

Includes: •2 x 6" carbon fibre woofers •2 x Vifa D19 dome tweeters •2 x pre built crossover networks.

Cat. CS-2590 **$229 Pr**

CABINETS

Includes: •2 x pre built cabinets •Grill frame pieces •Speaker cloth •Rear terminals •Innerbond •Ports •Speaker grill clips •Wire.

Jarrah Cat. CS-2592
Blackwood Cat. CS-2594 **$169 Pr**

Normally $398 Pr

BUY SPEAKER KIT AND CABINET KIT TOGETHER

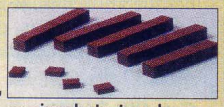
Pay Only $349 Pair

Quote from Rob Evans - Electronics Australia

At an all up kit price of just $349 a pair, these new two-way kit speakers from Jaycar may well represent about the best value-for-money around in high performance bookshelf loudspeakers.

FRIDGE MAGNETS

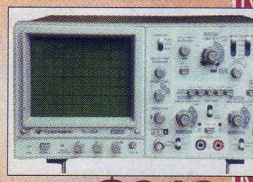
NEW



A packet of 100 small magnets that can be used for fridges, memos, holders or simply to teach children about magnetism. 000's of potential uses. 13(W) x 9(L) x 4(D)mm. Craftworkers! This magnet is ideal as the magnetic component for your fridge mounted novalty or message. Ask us for a quantity quote!! Cat. TH-1876

Pkt of 100 $4.95

25 MHZ CRO



See 96 Cat, P33 Limited qty available.
Cat. QC-1900
Was $749
Save $100
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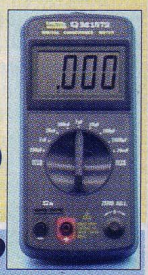
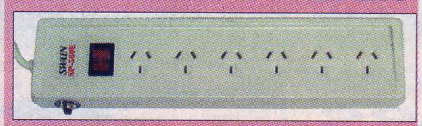
Includes two probes.

DIGITAL CAPACITANCE METER



0.1pf to 20,000uf.
Cat. QM-1572
Was $99.50
Feb $79.50
Save $20.00

6 WAY POWER OUTLET WITH MAINS FILTER

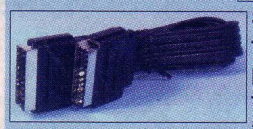


Not only is it a 6 way power board, it incorporates a voltage surge and spike protector and noise rejection filter network. Supplied with two metre cord and mains plug, safety shutters on each outlet, illuminated master on/off and even a safety circuit breaker. Cat. MS-4030

Was $43.95 Save $14.00
Now $29.95

NEW CATALOGUE NEXT MONTH

SCART LEAD

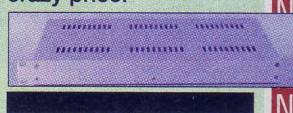


Scart plug to scart plug. Used to sell for around $25

Cat. AV-6550 **Only $5 ea**

44MM SILVER RACK BOX

Grab one for a spare at this crazy price. Includes front panel.



Cat. HB-5411 was $69.95
FEB $39.95 Save $30

STORAGE SYSTEMS

TOOLCASE

NEW

Quality ZAG brand, made in Israel. Amazing 6 year warranty! Its built to last. It has a tote tray inside, which is a tray with a handle to store tools like screwdrivers etc. It simply lifts out to reveal one large compartment which is the full size of the toolbox. Total size 405(L) x 205(D)x180(H)mm. Tool compartment size 375(L)x175(D) x100(H)mm. It is lock-able & has a tongue & groove lid system, which helps to keep water out. The box is so strong, you can sit on it to eat your lunch. A top quality low cost tool box. The unit it replaces sold for $39.95!!!

Cat. HB-6334 **$19.95**

PACK 'N' LATCH CABINET

NEW

Pack 'N' latch is a quality ZAG product, made in Israel. It has a 6 year warranty. It is the best plastic parts cabinet we have ever seen!! It is ideal for tran-sporting parts and can be attached to a wall. Each draw latches, so there is no chance of the drawers falling out, spilling the parts. There is 6 drawers, 4 x 38mm(H) and 2 x 58mm(H). The small drawers have 3 large compartments, which with the dividers supplied can become up tp 10 smaller compartments or any combination. The large drawers are one compartment, but can be made up to 5 smaller compartments, or any combination. There is a handle for carrying and screws and rawl plugs for wall mounting. Total size is 345(H) x 305(W) x 145(D)mm.

Cat. HB-6322 **$39.95**

TWIN ORGANISER

Quality ZAG brand, made in Israel. Amazing 6 year warranty! This product is a double sided tool/parts storage system. It has a carry handle so it can be carried like a briefcase. Each side is the same & has 18 separate compartments. All compartments have the same depth - 50mm and length 65mm, only the width changes - and there is 13 x 55mm wide, 4 x 85mm wide and 1 x 290mm wide. As its double sided, all the above numbers should be doubled - ie - 36 separate compartments in total. When the lid is closed, parts will not jump from one compartment to another. The lids are clear, so you can see what you are after without opening the lid. Total size is 350(L) x 280(H) x 130(D)mm. A top quality parts storage system.

Cat. HB-6346 **$29.95**

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UNBELIEVABLE SURPLUS SPEAKER DEALS

We have made a massive purchase of some discontinued speakers from Etone. The speakers are NOVIK brand and are made in Brazil. NOVIK have been around for some time, we even used to sell them some years ago. Ideal replacement speakers. Save up to 50%. Limited quantities.

12" WOOFER

Power handling 40WRMS Frequency response 30Hz - 3.5kHz. Paper cone, plastic front surround. Speaker weight 1.6Kg.

Cat. CW-2124 **Only $29.95ea**

10" WOOFER

Power handling 40WRMS Frequency response 35Hz - 4.0Khz. Paper cone, plastic front surround. Speaker weight 1286gr.

Cat. CW-2120 **Only $24.95ea**

5" MIDRANGE

Power handling 120WRMS system power. Suggested crossover points - 800Hz and 5Khz. Clear poly-propylene cone. Speaker weight 590gr.

Cat. CM-2070 **$14.95**

DOME MIDRANGE

Power handling 150WRMS system power. Suggested crossover points 500Hz & top crossover point between 5Khz and 12Khz. Speaker weight 810g. Size 130W x 114Hmm front. Cutout about 90mm dia. 1.5" (38mm) dome.

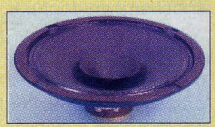
Cat. CM-2074 **$24.95**

6" 8Ω TWINCONE

Ideal low cost replacement speaker. Has a twincone and cardboard cone. power handling is around 6watts. Diagonal mounting holes 155mm. Weight 353gr.

Cat. AS-3013 **$7.95**

8" TWINCONE PA SPEAKER



This twincone 8" speaker is ideal for PA. It is very similar to our CE-2325 model, except that it does not have mounting holes for a line transformer. Power handling is 10WRMS. Frequency response is about 100Hz to 17,000HZ. Weight 430gr.

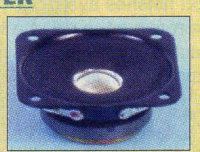
Cat. CE-2326 **$12.95**

ROUND CONE TWEETER

Power handling - about 50WRMS system. Frequency range 2K - 16Khz. Suggested crossover point is about 3Khz. Overall diameter 85mm. Cutout size - min.55mm. Weight 108gr.

Cat. CT-2001 **$9.95**

SQUARE CONE TWEETER



Power handling - about 50WRMS system. Frequency range 2K - 16Khz. Suggested x'over point is about 3Khz. Size - 57 x 57mm. Cutout size 55mm. Weight 93gr.

Cat. CT-2002 **$7.95**

PIEZO TWEETER

Power handling 120WRMS, no crossover required. Front panel size 135(W) x 65(H)mm.

Cat. CT-1915 **$8.95**

8MM CAMCORDER CLEANING KIT

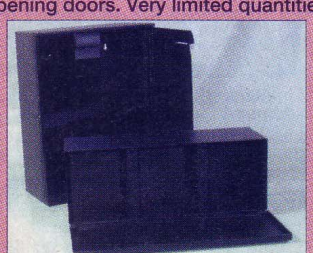
Keep your video camera in top shape! Kit includes: •Head cleaning tape •Bottle head cleaning fluid •Bottle lens cleaning fluid •Blower brush •50 sheets lens cleaning tissue paper.

Cat. AR-1420

Retail Price Was $24.95
Were selling For $12.95
February Sale only $7.95

CD STORAGE CASES

Priced way below normal. With black opening doors. Very limited quantities.



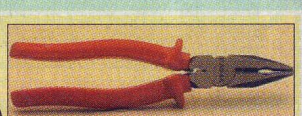
60 CD's	36 CD's
Retail $59.95	Retail $39.95
February Sale $25	February Sale $15
Cat. AR-1482	Cat. AR-1481

ROBO LIGHT

PIR controlled portable light. Buy one for your parents. Simply position on the floor, or on a table and when they walk near it at night, it will come on for them to see. Also ideal for verandahs, loos, toolsheds, etc, etc. Works on 4 x C batteries and has a 6VDC socket, so you could use it with a 240V plug pack. We have bought a quantity at a very good price. See 1993 cat where it was $34.95 **Cat. LA-5008**

February Sale $12.95 **Save $22**

ELECTRICIANS PLIERS



Quality big pliers (length 230mm)

Cat. TH-1895 **Wholesale Price is $35**

Was $25.00 **February Sale $12**

100 WATT SPEAKER FADERS

Control the volume of extension speakers. Supplied with plastic face plates. 50WRMS handling.

MONO
Cat. AC-1672
Was $19.95
Save $7.00
February Sale $12.95

STEREO **Cat. AC-1673**
Was $31.95 **Save $10.00**
February Sale $21.95

CD / AUX TO CAR FM SOUND FEEDER

Use your portable CD players, or walkman in your car. Also powers the player from the cars power.

See 96 Cat, page 68. **Cat. AR-1750**

Was $47.95 **Save $10**
February Sale $37.95

INNER EAR HEADPHONES

Supplied with set of spare ear pads. Frequency range 20Hz - 20kHz.

Cat. AA-2014
Was $3.95 **Save $1.95**
February Sale $2.50

HIGH QUALITY HEADPHONES

If you want something better than the low cost ones above.

See 96 Cat page 57.

Cat. AA-2015
Was $8.50 **Save $3**
February Sale $5.50

27MM (1.1") MYLAR SPEAKER

8 ohm, 0.25 watt. **Cat. AS-3002**

Was $2.60

February Sale

1-9	$1.50
10-99	$1.20
100+	$0.80

UNDIRECTIONAL DYNAMIC MIC

Complete with on/off switch, cable to 6.5mm plug. 600Ω imped, 80 - 12,000Hz frequency. **Cat. AM-4090** **Was $9.95**

February Sale $6.95

30 METRE ROLL OF SIX CORE ALARM CABLE

Cat. WB-1593
Cat Price $27.95
Feb $13.95 **1/2 PRICE**

JAYCAR WHOLESALE (02) 9743-5222

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CAR ALARM DEALS - AMERICAN LEGEND / EQUATOR

American Legend Car Alarm

NEW

Features learning remotes: See Nov/Dec Advertisements.

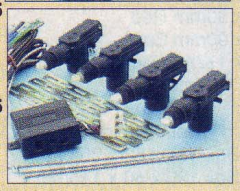
Deal 1: Buy the alarm at $139.50 and pay only $10 extra for the siren. (LA-8908)
Total $149.50 Save $15.95

Deal 2: Buy the alarm at $139.50 and pay only $30 extra for the battery back up siren.
Total $169.50 Save $29.95

Deal 3: Buy the alarm and battery back up siren and 4 door central door locking for only **$249** and save **$39.50.**

ALARM	$139.50	LA-8912
SIREN	$60.00	LA-8910
LOCKING	$89.00	LR-8830
Normally	**$288.50**	

$249 and save **$39.50**



LA-8908 LA-8910

Equator Car Alarms

See cat for full details

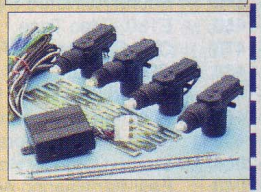
NEW

EQUATOR LA-8902

Deal 1: Buy the alarm at $169 and pay only $10 extra for the siren. (Siren LA-8908) **Total $179.00 Save $15.95**

Deal 2: Buy the alarm at $169 and pay only $30 extra for the battery back up siren (Siren LA-8910).
Total $199.00 Save $29.95

Deal 3: Buy the alarm and battery back up siren and 4 door central door locking for $269 and save $48
ALARM: $169.00 SIREN: $60.00 LOCKING: $89.00 **Normally $318**
Total $269 Save $48



EQUATOR LA-8905

Deal 1: Buy the alarm at $229 and pay only $10 extra for the siren. (Siren LA-8908) **Total $239.00 Save $15.95**

Deal 2: Buy the alarm at $229 and pay only $30 extra for the battery back up siren (Siren LA-8910).
Total $259.00 Save $29.95

Deal 3: Buy the alarm and back up battery siren and 4 door central door locking for only $329 and save $49.
ALARM LA-8905: $229 SIREN LA-8910: $60 LOCKING LR-8830: $89
Normally $378 Total $329 Save $49

LA-8908 LA-8910

GUITAR SPEAKER MONTH

Save Big $$$

See 96 catalogue page 49 for full details.

10" 65WRMS SPEAKER
Feb Sale $37.50
Was $57.50 Save $20 Cat. CG-2376

12" 100WRMS
Was $99.50
Feb Sale $69.50
Save $30.00 Cat. CG-2380

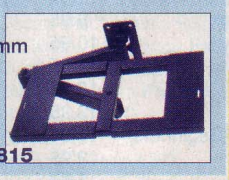
15" PROFESSIONAL 200WRMS Was $239
Feb Sale $189
Save $50.00 Cat. CG-2388

SAVE ON WALL BRACKETS

See 96 Cat, page 54 for full details.

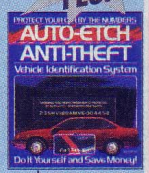
Standard Size
Shelf width 300(W)x280(D)mm
Was $34.95
Feb Sale $24.95
Save $10 Cat. CW-2810

Large Size
Shelf width 814(W)x266(D)mm
Was $78.95
Feb $58.95
Save $20 Cat. CW-2815



CAR WINDOW ETCHING KIT

WHAT A FLOP



Etch your vehicle identity number (VIN) on your cars' windows for extra protection. Do it yourself and save a fortune.

Cat. LA-5120 Was $39.95
February Only $20
Spare etch cream available for $5.00 Was $9.95 Cat LA-5125

VIBRATION ALARM

WHAT A FLOP

Keep the cat off the lounge! "Tattle Tale" can detect vibration in an object or surface without any apparent motion. Ideal for pet training, security etc.
Made in U.S.A. Cat. LA-5270
Was $39.95 **February $20**

24 TO 12V REDUCER

Current rating 2.8A. See 96 Cat, page 79 for full details.
Cat. MP-3058 **Cat Price $39.95**
Feb $29.95 Save $10

REMOTE CONTROL SWITCHES

Ideal for garage doors, central door locking, alarms, etc, etc, etc.See 96 Cat P156 for details.

Latching Unit

Both N/O and N/C contacts.
1 receiver and 2 transmitters.
Cat. Price $79.95
Feb Sale $59.95
Save $20 Cat. LR-8824
Spare remote Cat. LR-8825
Was $23.95 Feb. $16.95 Save $7

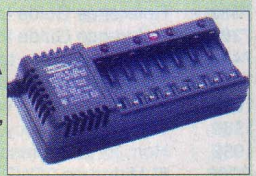
Momentary Unit

Both N/O and N/C contacts.
1 receiver & 2 transmitters.
Cat. Price $99.95
Feb $69.95
Save $30 Cat. LR-8826
Spare remote Cat. LR-8827 Was $23.95 Feb. $16.95 Save $7

0-30V DC 2.5AMP VARIABLE LAB POWER SUPPLY

•Variable output voltage 0 to 30V •Variable current limiting 0 to 2.5A •Fixed 5 and 1.2V output at 500mA •Seperate voltage & current meters. See 96 Cat P34 for full details.Cat. MP-3080 Was $199.50
February $159.50 Save $40

8xAA FAST CHARGER

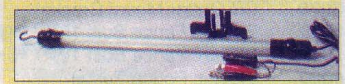


Charges 2, 4, 6 and 8 AA or AAA at a time, fast. See 96 Cat, page 74 for full details
Cat. MB-3510 Was $39.95
February $29.95
Save $10 This Month

12VDC TO 240VAC INVERTER

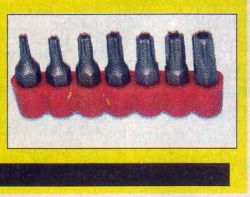
Power many 240V products from 12VDC car power. See 96 Cat page 75 for full details and specifications.
Cat. MI-5038 Was $159.50
February $129.50 Save $30

12V 13W FLUORO LAMP



Stands up, hangs up, plugs into cigarette lighter or clips onto battery. Length approx 600mm.
Cat. ST-3020
Cat Price $19.95
February $13.95
Save $6 This Month

TAMPER PROOF TORX SCREW BIT SET



Includes: T10, T15, T20, T25, T30, T40. Made from chrome vanadium steel and heat treated.
Cat. TD-2034 Was $9.95
Feb. $5.00

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1800 022 888

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RONICS JAYCAR ELECTRONICS

DISCONTINUED PRODUCT SELLOUT

There is a very limited quantity of many of these products available. They may not be in every Jaycar store. Most products are not available from dealers. Be quick.

Cat #	DESCRIPTION	WAS $	NOW $
AA-0300	30 Watt Stereo AMP Module	76.95	49.95
AA-0324	Stereo Preamp Mic / Phono Module	24.95	14.95
AA-0342	Sound Activated Switch Module	24.50	14.95
AR-1450	E180 Video Tape	3.95	2.50
AR-1476	CD/LP Polish and Protector	2.95	1.95
AR-1480	CD Modular Racking System	12.50	6.95
AR-1483	Record (LP) Stand Holds 30 LP's	1.50	1.00
AR-1484	7" 45 Plastic Record Covers Pkt. 50	4.95	2.95
AR-1488	8mm / VHS-C Storage Case	7.95	4.95
AA-2004	Stereo Cordless Headphones	79.95	55.00
AA-2040	Easi-Ear Hearing Aid	14.95	7.95
AR-1490	Scotch Video Cassette Relabel Tape	2.50	1.00
AR-2210	10 Band Radio AM / FM / LW / SW	29.95	19.95
AA-2050	Monopod - 4 Section with Pouch	39.95	29.95
AS-2965	6 Watt Yellow Amplified Speakers	19.95	10.95
AA-3090	Car Battery Isolator	5.95	3.95
AA-3096	Car Battery Protector	19.95	14.95
AS-3190	Communication Speaker. + Noise Filter	24.95	14.95
AB-3461	12VDC 79DB Buzzer	2.95	1.50
AM-4084	Microphone Dual Impedance Undirectional	29.95	19.95
AM-4100	Spring Loaded Microphone Holder	6.95	3.50
AV-6508	Gold BNC-BNC Video Lead 1.8M	9.95	4.95
AV-6552	Scart to RCA/BNC Plugs 1.5M Video Lead	24.95	14.95
AV-7020	64 CD Holder-Smoke Colour Doors	14.95	7.50
AV-7021	100 CD Holder-Smoke Colour Doors	14.95	7.50
BM-2147	Computer Fundamentals Book	19.95	12.95
BM-2490	Satellite Cable T.V. Book	19.95	9.95
BM-4550	Substitution Data IC for TV & VCRs Book	19.95	12.95
BB-7010	Beginners Guide TTL IC's Book	13.95	7.95
BB-7017	Build Short Wave Receiver Book	11.50	6.95
BB-7018	Introduction to Amateur Radio Book	9.95	5.00
BB-7037	Light in Electronics Book	10.95	6.95
BB-7049	45 Terminal Block Project Book	14.95	7.95
BB-7000	Circuit Source Book 1	13.95	7.95
BB-7001	Circuit Source Book 2	13.95	7.95
BB-7008	Electronic Modules & Systems for Beginners	11.50	6.95
BB-7012	OP AMP Users Handbook	13.95	7.95
BB-7016	Crystal Set Construction Book	5.50	3.00
BB-7020	25 Simple Shotwave Aerials Book	6.95	4.00
BB-7025	Practicle Electronics Timing Book	13.95	7.95
BB-7027	Preamp and Filter Circuit Book	11.50	6.95
BB-7028	Popular Electronics Projects Book	11.50	6.95
BB-7033	PA Speaker System Book	12.95	7.50
BB-7036	Electronics Projects for Video Fans Book	13.95	7.95
BB-7042	50 Circuits Using Diodes Book	9.95	4.95
BB-7043	Indoor/Windows Antenna Book	9.95	4.95
BB-7044	Experimental Antenna Topics Book	9.95	4.95
BB-7048	Projects for Radio Amateuers Book	14.50	7.95
BB-7050	Digital Technology Book	14.95	7.95
BB-7301	Int Satellite Communications Book	16.95	8.95
BB-7302	Reference Guide to Practical Electronics Book	13.95	8.95
BB-7304	Reference Guide to Basic Elect.Terms Book	16.95	8.95
BB-7401	Beginners Guide to Midi Book	13.95	7.95
BB-7404	Computer Hobbyist Handbook	16.95	8.95
CT-1905	Economy Piezo Tweeter 75W Peak	12.50	7.50
CT-1950	1" High Frequency Compression Driver	119.00	79.00
CT-1952	Horn for Compression Driver	99.00	65.00
CM-2086	5" Midrange 25WRMS 4Ω	14.95	9.95
CS-2242	8" Re/Sponse 4Ω Carbon Fibre Woofer	99.50	69.50
CS-2510	Surround Sound Centre Speaker	99.95	69.95
CE-2320	8" Coax Speaker 8Ω	39.95	29.95
CS-2435	Mini Outdoor 3 Way Speaker - Pair	59.95	45.00
CX-2635	Car Crossover 3 Way 200Hz/5K - Pair	59.95	45.00
CX-2636	Car Crossover 3 Way 1.3K/5K - Pair	79.95	50.00
CW-2800	Bracket to Suit Book Shelf Speaker - Pair	3.95	2.50
CW-2820	Bracket for Microwave /Speakers - Up to 31Kg	34.95	18.00
DC-3070	CB Gutter Mount Bracket	17.95	10.00
DE-6010	Electric Fence Built 12V / 2KM	129.50	99.50
DE-6015	Electric Fence Built 12V / 10KM	179.50	139.50
DE-6020	Electric Fence Tester	29.95	19.95
DE-6030	Star Post Insulators Pkt.25	8.95	5.95
DE-6032	Wood Post Insulators Pkt.25	9.95	6.95
DE-6036	Bull Nose Insulators Pkt.10	6.50	3.50
DE-6040	Wire Join Clamps Pkt.10	6.95	3.95
DE-6050	Gate handle	4.95	2.95
DE-6052	Gate anchor	2.65	1.20
DE-6055	Spring Gate Set	12.95	7.95
DE-6060	Poliwire UV Stabilised Wire 200M Roll	26.95	16.95
DE-6065	Hot Tape 200M Roll	39.95	24.95

Cat #	DESCRIPTION	WAS $	NOW $
HP-0106	VCR E Clips / Washer Kit	14.95	10.00
HP-0500	4mm x 10mm Posidrive Bolt Pkt.10	1.70	0.90
HP-1101	3mm Black LED Clips Pkt.100	11.50	6.95
HM-3044	EZ Hook 90mm Red	1.60	1.00
HM-3045	EZ Hook 90mm Black	1.60	1.00
HM-3046	EZ Hook 137mm Red	3.90	1.50
HM-3047	EZ Hook 137mm Black	3.90	1.50
HM-3712	Gold Wire Wrap Pins Pkt.20	4.95	2.50
HC-4060	Gold Car Power Terminal for 8GA Wire	7.50	4.00
HB-5000	Diecast Box 100 x 52 x 25mm	9.25	5.00
HB-5016	Diecast Box 190 x 60 x 110mm	26.50	15.00
HB-5100	Bargain Computer Case	9.95	4.00
HB-5410	44mm Black Rack Box Complete	69.95	39.95
HB-5412	88mm Black Rack Box Complete	84.95	54.95
HB-5413	88mm Silver Rack Box Complete	84.95	54.95
HB-5615	Enclosure #1 Natural Finish	8.00	4.00
HB-5800	Vacuum Storage Case	39.95	15.00
HB-5802	Pump for Vacuum Storage Case	17.95	6.00
HB-6340	Resistor Storage Tray	7.20	3.95
HB-6341	Lid to Suit Resistor Storage Tray	2.95	1.50
HB-5913	Instrument Case 150 x 160 x 65mm	16.95	10.00
HB-5940	Radar Detector Plastic Box	3.95	1.95
HB-6314	Utility Carry Case Kit	29.95	19.95
HB-6323	3 Drawer Mini Parts Cabinet	4.95	2.95
HB-6324	Clear Plastic Double Sided Storage Box	5.95	3.50
HB-6332	Toolbox Large Plastic - Black	29.95	19.95
HB-6345	Component Carry Case	17.95	9.95
HB-6338	Large USA Toolbox - Lockable	39.95	29.95
HB-6510	T Case Grey Cutout	24.95	12.95
HB-6512	T Case Black Cutout	24.95	12.95
HB-6514	T Case Grey No Cutout	24.95	12.95
HB-6516	T Case Black No Cutout	24.95	12.95
HC-6902	Nokia 232 Leather Black Case	29.95	10.00
HC-6906	Motorola 9000 Leather Black Case	29.95	10.00
HC-6909	NEC Sportz Leather Black Case	29.95	10.00
HC-6910	NEC P3 Leather Black Case	29.95	10.00
HC-6913	Motorola Flare 6200 Black Case	29.95	10.00
HC-6914	Nokia 2110 Black Case	29.95	10.00
HH-8548	Heatsink Black 74 x 136 x 46mm	13.95	9.50
HH-8561	Heatsink Suits 2 x TO3 75 x 100 x 33mm	6.50	2.95
HG-9978	Photoresist Developer	16.50	10.00
KA-1109	Electric Fence Kit EA 9 / 82	24.95	12.95
KA-1115	300 Watt Amp Module EA 6 / 80 Kit	89.95	69.95
KA-1116	300 Watt Power Supply Inc.Transformer Kit	115.00	75.00
KA-1117	300 Watt Speaker Protector Kit	19.95	9.95
KA-1630	12V Car Dash lamp Flasher Kit EA 2/86	12.95	6.95
KA-1763	Temperature Controller Kit	44.95	29.95
KA-1736	18V 1 Amp Bench Power Supply Kit	79.95	59.95
KA-1764	Active Subwoofer X-Over Kit	69.95	39.95
KA-1769	Minispot Alignment Source Kit	23.95	12.95
KA-1773	Economy Surround Sound Kit	69.50	45.00
KA-1776	Parallel Breakout Box Kit	45.00	27.50
KA-1779	Induction Loop Kit for Headphones	19.95	10.95
KA-1780	Low Cost Train Controller Kit	29.95	17.95
KE-4724	ETI 1406 Parametric EQ Kit	26.95	18.95
KE-4729	Guitar Pre-amp Kit	39.95	29.95
KC-5019	100 Watt Amplifier Module Kit	45.95	29.95
KA-1741	Surround Sound Decoder Kit	39.95	24.95
KA-1766	In-A-Flash Cable Checker Kit	22.95	12.95
KC-5031	Optical Tachometer Kit	49.95	34.95
KC-5091	20W Inverter for Fluro light Kit	32.95	22.95
KC-5106	Light Beam Relay Kit	34.50	24.50
KC-5107	4 Channel Guitar Mixer / Pre-amp Kit	49.95	34.95
KC-5134	Digital Voltmeter Kit	32.95	22.95
KC-5148	10 LED Chaser Kit	16.95	10.95
KC-5164	6V Sealed Lead Acid Battery Charger Kit	29.95	19.95
KC-5174	3 Spot Sine Wave Oscillator Kit	39.95	24.95
KC-5173	Talking Head Light Reminder Kit	59.95	36.95
KC-5179	Digital Effects Unit Kit	159.00	99.00
KC-5188	Door Minder Kit	27.95	14.95
KC-5194	Geiger Counter Kit	179.50	119.50
KC-5197	5 Band Equaliser Kit	39.95	24.95
KC-5199	Woofer Stopper MK11 Kit	79.50	55.00
KC-5205	Hi-Volt Insulation Tester Kit	79.50	55.00
KC-5059	Radfax Decoder Kit	44.95	29.95
KC-5206	Automatic 10 Amp Battery Charger Kit	179.50	129.50
KC-5207	Low Ohms for DMM's Kit	29.95	19.95
KJ-6690	Solar Educational Kit	10.95	7.95
KJ-6692	Educational Solar Energy Kit	24.95	14.95

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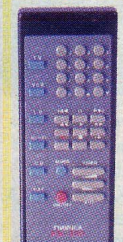
Cat #	DESCRIPTION	WAS $	NOW $	Cat #	DESCRIPTION	WAS $	NOW $
KJ-6720	Chrystal Radio Technokit	14.95	10.00	SB-2568	Motorola Micro Tac Nicad 700MAH Battery	59.50	29.50
KJ-6721	MW IC Radio Technokit	14.95	10.00	SB-2562	Nokia 2110 Ni-Mh 1500MAH Battery	89.50	40.00
KJ-6722	Metal Detector Technokit	14.95	10.00	SB-2574	Motorola 4800 Nicad 1400MAH Battery	69.50	35.00
KJ-6723	Home Alarm Technokit	14.95	10.00	SB-2580	NEC P3 Nicad 700MAH Battery	59.50	25.00
KJ-6724	Audie Amplifier Technokit	14.95	10.00	SB-2582	NEC Sportz 1000MAH Nicad Battery	49.50	29.95
LT-3100	TV VHF Spiral Antenna Indoor	9.95	5.95	SL-2830	150 Globe Outdoor Garden Light Set	69.95	39.95
LT-3250	Guy Wire Kit	45.00	30.00	SL-2880	Blinking Safety Light Belt	24.95	10.00
LA-5002	Alarm Pressure Mat - Large	29.95	19.95	ST-3035	Eveready Anywhere Light	6.95	4.00
LA-5012	16 Tune Doorbell - Wired	14.95	8.95	TS-1200	Temperature Controlled Soldering Iron	39.95	19.95
LA-5020	360° Ceiling Mount PIR	49.95	34.95	TS-1415	Upright Butane Micro Torch with Ignition	39.95	24.95
LA-5022	Quality Mini PIR + 4 Lenses	61.50	36.95	TS-1420	Stand Up Butane Soldering Iron	49.95	34.95
LA-5035	Microwave PIR Detector	99.95	50.00	TS-1600	Variable Temperature Soldering Station	189.50	149.00
LA-5088	Vibration Detector Switch	3.95	1.95	TH-1800	Alignment Tool Set (Universal)	6.95	3.75
LA-5095	Window / Door / Cabinet Alarm	14.95	8.95	TH-1930	4 Pin US Plug Metal Crimping Tool	24.95	14.95
LA-5138	Outdoor 500W Halagen Light/PIR	49.95	34.95	TH-1952	Set Square Set - 4 Pieces	22.95	14.95
LA-5262	Quality 12V Jumbo Siren	52.95	36.95	TH-1954	12mm Plastic G Clamp	5.95	2.95
LA-8900	ITACO Remote Control Car Alarm	139.50	99.50	TH-1956	24mm Plastic G Clamp	7.50	3.95
LA-8950	Volumetric Remote Control Car Alarm	69.50	39.50	TH-1958	150mm Sliding Bar Clamp	13.95	7.50
MF-1095	JT-144 28 / 0 / 28V at 2 Amp Transformer	44.95	29.95	TD-2006	Long precision Screw Drivers - Set of 3	7.95	4.95
MM-2003	9V Centre Tap 150mA Transformer	5.95	3.95	TD-2050	All Weather Multi Tester	9.95	5.95
MM-2011	36V Centre Tap 150mA Transformer	5.95	3.95	TH-1766	Replacement Punch to Suit Adel Nibbling Tool	27.95	17.95
MM-2017	JT-307 47 / 0 / 47V 3 Amp Transformer	89.50	49.50	TH-1950	Mitre Box Set	24.95	14.95
MM-2500	PA Line Transformer	5.00	2.50	TD-2012	Ceramic Adjuster Tool	13.95	8.95
MB-3502	Solar Battery Charger to Suit 4 x AA Nicads	14.95	9.95	TD-2422	1.2mm PCB HSS Drill Pkt.10	10.95	6.00
MB-3503	Solar Car Battery Booster	29.95	19.95	WA-1054	Stereo 6.5mm Patch Cords Pkt.5	6.95	4.95
MB-3505	Solar Charger 2 x D, C, AA, AAA, Nicads	24.95	14.95	WB-1999	75 ohm Light Duty Coax Cable 30M/Roll	16.95	10.00
MB-3525	Alkaline / Nicad Battery Charger	49.95	36.95	WB-2000	75 ohm Light Duty Coax Cable Per Metre	0.90	0.40
MI-5040	12-240VAC Inverter 300VA	199.00	149.00	WW-4347	Green Wire Wrap Wire - 100 Foot Roll	8.25	4.95
MI-5050	12-240VAC Inverter 500VA	419.00	275.00	WM-4506	34 Way IDC Cable Per Metre	3.95	1.95
PS-0125	3.5mm Mono Line Skt Red	0.85	0.40	WB-2004	75Ω Heavy Duty Coax per Metre	1.10	0.60
PS-0290	RCA Skt, 2 x 3 PCB Mount	3.95	1.50	XC-0106	Clock Movement with Westminster Chimes	21.50	12.95
PL-0752	1 x 3.5" Disk Drive Power Skt to 2 x 3.5' Skt	5.95	2.00	XC-0107	Clock Movement with 12 Melody Chime	21.50	12.95
PL-0753	1 x 3.5" Disk Drive Power Skt to 2 x 3.5' Skt	5.95	2.00	XC-0152	Electric Timer Module	19.95	12.95
PA-0888	Commodore Edge Connector	6.95	2.50	XC-0250	Talking Clock - Battery Operated	24.95	14.95
PP-0892	IDC Type Centronics Plug 36 Way	5.95	2.95	XC-0280	Quickpick Keyring Lotto Selector Game	14.95	9.95
PA-0893	SCSI Terminator Centronics 50 Way Plug	9.95	4.95	XC-5160	Plastic Foot rest for Computer Operator	19.95	5.00
PA-0894	Centronics Bender Changer Male to Male	12.95	4.95	XC-4738	3.5" 2HD Computer Disks Pkt.10	5.95	4.00
PA-0895	Centronics Bender Changer Female to Female	12.95	4.95	XB-4980	Nicad Discharger - Fully Built	59.95	42.50
PL-0934	SCSI Cable Centronics 50 Way Male to Male	19.95	9.95	YT-6010	15 Metre Telephone Extension Reel	22.95	15.00
PS-4100	IEC 320 Line 240V Skt with 1.8m Cord	6.50	3.95	YT-7041	Audioline 830 Answering Machine	79.95	49.95
PI-6549	14 Pin DIL IDC Header Plug	1.60	1.00	ZR-1008	IN4007 Diodes Pkt.100	12.00	5.00
QM-1022	19 Range Analogue Multimeter	39.95	29.95	ZD-1727	5mm Blue LED	2.95	2.00
QM-1450	Brymen 328 Automotive DMM	239.00	179.00	ZD-1751	3mm Blue LED	3.95	2.50
QC-1910	50 MHZ Oscilloscope	1195.00	950.00	ZD-1959	10mm Orange LED	0.75	0.40
QP-5058	VU Panel Meter	11.95	5.95	ZL-3318	LM 318H High Performance OP Amp	4.95	2.95
QP-5513	DPM-200 LCD Lascar Panel Meter	98.00	59.00	ZL-3832	CA 3130E Mini DIP OP Amp	3.50	1.95
QM-7200	Digital Hygrometer with Min.Max Temp.	45.00	37.50	ZC-4012	4012 CMOS Dual 4 Input Nand Gate	0.80	0.20
QM-7230	Majic ear Hearing Aid	19.50	12.50	ZS-5158	74LS 158	1.50	0.30
QM-7260	Microwave Oven Leakage Detector	13.95	9.95	ZS-5821	74121 One Shot	1.50	0.30
QM-7265	Large Digit Calculator	7.95	3.95	ZK-8820	SLB0586 Light Dimmer IC	13.95	5.00
QM-7320	64K Databank	129.50	79.50	ZK-8836	MC1377 PAL Encoder	7.50	2.95
QM-7324	PC Interface for QM-7320/7330/7325	39.50	29.50	ZT-2165	BC 557 Pkt.100	7.95	5.00
QM-7330	128K Databank + 6 Laguage Translator	179.00	99.00	ZT-2454	2SK 134 TO3 (N) Mosfet	9.95	5.00
QM-7325	128K Databank	149.00	89.00	ZL-3572	NE 572 Stereo Compandor IC	5.00	2.50
RQ-5264	1.8432 MHZ Crystal	1.00	0.30	ZC-4043	4043 CMOS Quad RS Latch	2.20	1.00
RQ-5283	5.000 MHZ Crystal	5.50	1.00	ZC-4052	4052 Dual 4 Channel Analog Multiplexer	1.95	0.80
SS-0850	4DPT Slide Switch Minitaure	1.50	0.80	ZC-4900	74 COO Quad 2 Input Nand Gate	1.00	0.40
QM-7315	32K Digital Diary	59.95	39.95	ZZ-8454	2716 Eprom	16.95	8.00
SB-2552	Nokia Nicad Battery Suit 101/121 800MAH	69.50	29.50	ZZ-8468	27128 Eprom	12.95	5.00
SB-2554	Nokia Nicad Battery Suit 101/121 1100MAH	79.50	39.50	ZZ-8470	27256 Eprom	11.95	5.00
SB-2556	Nokia 232 Nicad 1000MAH Battery	69.50	25.00	ZZ-8473	27512 Eprom	12.95	5.00
SB-2558	Nokia 232 Nicad 1100MAH Battery	79.50	29.50	ZZ-8510	P8086-2 16 Bit CPU 5 MHZ	5.00	2.00
SB-2560	Nokia 2110 Nicad 1100MAH Battery	59.50	20.00	ZZ-8520	D41264C-15 RAM	2.00	1.00
SB-2550	Nokia 100 Nicad 1000MAH Battery	69.50	39.50	ZK-8823	Max 231 Converter	12.95	6.95

EXCITING PLAYMASTER PRO SERIES IV PREAMP & REMOTE CONTROL OFFER - EXCLUSIVE TO JAYCAR

We're celebrating the release of the new Pro 1V Preamp by offering you the chance to grab our AR-1710 programmable Remote Control for just $20.00 when purchased together with the Pro 4 Preamp - a saving of $23.95 off our price. In keeping with the professional approach of this kit, we include a short form remote control (i.e.PCB and electronic components only) to be used as a programming source for learning remote control unitrs. This tiny remote can them be stored away and used to program your learning remote when required. You can even retire any existing remote controls and just use the AR-1710 on its own! See page 147 of our 1996 catalogue for full details of the AR-1710 Programmable Remote. The Jaycar Pro 1V Preamp comes standard with the following: low radiation toroidal mains transformer (unlike our competitors who, as rumour has it, will be supplying cheap and inferior chassis transformers); 1% metal film resistors and MKT capacitors throughout; gold RCA sockets; lower noise version of the 5534A op amp IC's; quality machined pin IC sockets; exclusively engineered chassis as used in the prototype (fully punched and professionally silk screened, of course!) plus all specified electronic components, See Electronics Australia December 96 / January 97 for full and complete details.

NEW



Cat. KA-1790

Special Pro 1V Kit Introductory Price $229.00

AR-1710 Remote Control $ 20.00

Complete Pro 1V / AR-1710 Deal $249.00

Beware of inferior versions of the Pro 1V being offered by our competitors that include a flimsy aesthetically - poor kit remote, together with non - standard hardware and components.

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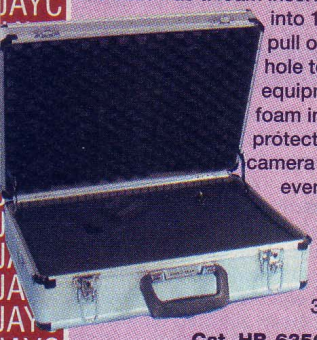
ALUMINIUM CASE WITH FOAM

NEW

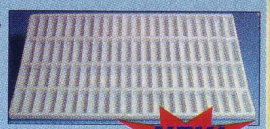
This case has a foam insert which has been perforated into 15mm square holes. Simply pull out the squares and form a hole to put your valuables equipment in. The lid also has a foam insert for complete protection. Ideal for carrying your camera or video equipment, or even wine and glasses! Case is lockable and two keys are supplied. Case is the same size as our economy attache case. Size 450(W) x 320(H) x 125mm(D).



Cat. HB-6356 **$69.50**

RESISTOR STORAGE TRAY

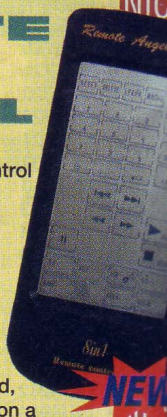
Brand new model for 1997. Now with 88 compartments! (The old model had 36). Enough to hold one of our RR-1697 resistor packs (10 of every 1/4w from 1Ω to 10m). Each compartment will hold 40 resistors if they are not bandoleered. If bandoleered, they form a friction fit with the ends of the cell and will not fall out. Now with lid. Also included is a clear slide on lid, that keeps all the goodies in their place. Size 420mm(L) x 275mm(W) x 13mm(D). Compartmenr size 60mm(L) x 16mm(W) x 8mm(D). An excellent low cost way to store resistors, capacitors, transistors, diodes, nuts, bolts, buttons etc.,etc.,etc.



NEW

Cat. HB-6342 **Only $11.95**

ULTIMATE REMOTE CONTROL



This must be the ultimate remote control! It is a learning remote control and will operate up to 8 pieces of equipment. It is quite unique in as much as it has a different LCD display for each piece of equipment its controlling. For example, the VCR mode displays the typical VCR functions and when switched to the TV, the TV controls appear on the screen. And, if you don't want all the functions on a display, you can simply delete what tou don't want. There are 28 programmable visual keys for each individual component. You can teach any command key , any function in each of the 8 devices. The 8 functions are:-TV, VCR, CD, LD, AMP, Tuner/Taper, Sel1, Sel 2. Sel 1 and 2 are spares - so if you have two VCR's for example you simply programme sel 2 for the 2nd VCR. An amazing piece of equipment, that is well worth the asking price..

NEW

Cat. AR-1720 **Only $179.50**

NEW MICROTAC BATTERIES

SLIM NI-MH 900 MAH

Only 12mm thick **Cat. SB-2569**

$79.95

JUMBO 2100 MAH NI-MH

Cat. SB-2571

$79.95

NEW

COUNTERSINK TOOL

This 19mm diameter tool makes countersinking screws easy. The carbon steel blade is hardened and black finished.

The countersink angle is the standard 90°. Simply drill hole, insert the tool and turn. Comfortable orange coloured handle

Cat. TD-2026 **$5.95**

POCKET DMM'S REDUCED

MANUAL

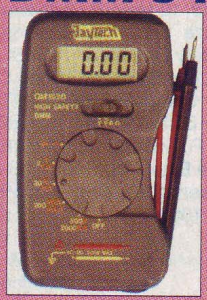
3.5 digit, wrap around leads, small size, one hand operation, continuity buzzer, diode test.

Cat. QM-1520

Was $34.95

Now $26.95

Save $8.00



AUTORANGE

3.75 digit, data hold 3999 count, wrap around leads, small size one hand operation, continuity buzzer, diode test. **Cat. QM-1540**

Was $49.95

Now $39.95

Save $10.00

TWO WAY MINI MONITORS

These sound great, and at this months price, they sound even better. Power handling 35WRMS. See catalogue page 48 for details.

Cat. CS-2428 **Were $119.50 Pair**

FEB $99.50 PAIR

Save $10.00

ILLUMINATED DOORBELL

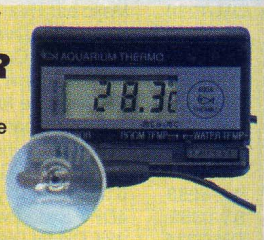
NEW

Visitors really appreciate seeing the doorbell at night on your verandah. No more groping around in the dark looking for your doorbell!! This one has a small globe mounted behind which illuminates the pushbutton and an area where you can place your name or street number. Black colour, with white pushbutton. Supplied with 12V globe, which also works on lower voltage. Spare globe available.

Cat. SP-0782 **$4.95**

AQUARIUM THERMOMETER

Keep an eye on your aquarium thermometrer. There is a temperature probe on the end of 1mt. cable.



Cat. XC-0128 Was $22.95

Feb. $16.95 Save $6

SHIELDED DOME TWEETER

Ideal for use near TV's and monitors.
System power handling 80 watts.
Frequency response 3K - 20KHz.

See cat page 45 for full details. Cat. CT-2006

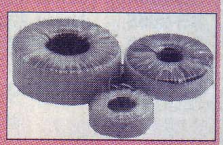
Was $16.95
Save $6.95 FEB $10

20VA TOROIDALS

Low profile. Will fit into a 44mm rackcase.
Size: OD 75mm, ID 21mm, 30mm high.

Cat. MT-2080 7.5V + 7.5 VOLT

Cat. MT-2082 9.0V + 9.0 VOLT



Were $19.95ea.

Febuary $12.95ea **Save $7.00**

5" TWO WAY CAR SPEAKERS

Power handling 25 wats RMS. See catalogue page 59 for full details.

Cat. CS-2254

Was $34.95

Feb. $24.95 Save $10

LARGE DIGIT ADJUSTABLE STICK ON TIME

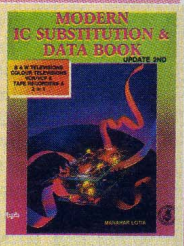
This clock has large digits, has an adjustable swivel base. Base has double sided tape for mounting.

Cat. XC-0225

Was $9.95 Save $3

Feb. $6.95

SUBSTITUTION & DATA FOR TV'S & VIDEOS



This book includes:
•General information •Functions •Pin details •Voltages •Block diagrams •Pin configurations •Substitutes on about 160 common audio, video, regulator and amplifier IC's used in TV's and videos. Prefixes include "A, AN, CA, CX, HA, KA, LA, M, TA, TBA, TDA, UPC" and many more. 264 pages - softcover - 210 x 275mm.

Cat. BM-4550 **Was $19.95**

Feb. $12.00 Save $7.95

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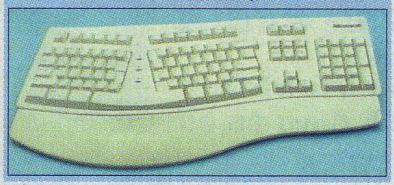
MICROSOFT NATURAL KEYBOARD

This keyboard helps you work comfortably by naturally positioning and supporting your hands, wrists and forearms. 104 key layout.

Cat. XC-5090 **Feb.$85**



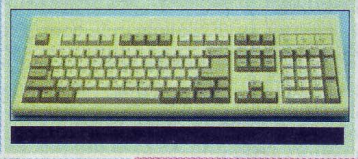
WINDOWS 95 104 KEYBOARD

Economically priced keyboard with 104 keys, as suitable for Windows 95.

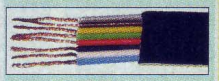
Cat. XC-5092

Was $39.95 Save $14.95

Feb. $25.00



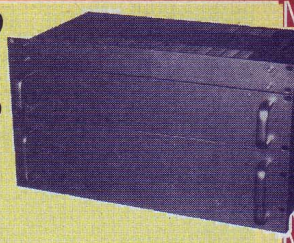
BLACK AUSTEL APPROVED TELEPHONE CABLE



4 Core 85¢ mt.
$51/100mt. Roll
Cat. WB-1623

8 Core $1.30 mt.
$82/100mt. Roll
Cat. WB-1625

SAVE ON PRO RACK CASE



1 Unit Cat. HB-5120
Was $75.00
Feb. $59.00
Save $16.00

2 Unit Cat. HB-5125
Was $99.50
Feb. $79.50
Save $20.00

3 Unit Cat. HB-5130
Was $109.50
Feb. $89.50
Save $20.00

INSIDE / OUTSIDE DIGITAL THERMOMETER WITH CLOCK AND DATE

Look at both temperatures at once.

See 96 Cat. page 171 for full details.

Cat. XC-0125
Was $19.95
Feb. $15.00
Save $4.95

16 TUNE DOORBELL

Cat. LA-5012
Was $14.95
Feb. $8.95

18 DRAWER STORAGE

It has large size drawers for storing larger items. There are 13 small drawers, 4 large & 1 extremely large. Overall size is 305x 355x 155mm. Cat. HB-6318

Was $22.95 Save $5
Feb. $17.95

"POCKE" TORCH

PIEZO ELECTRONIC WINDPROOF BURNER
Turn a common disposable cigarette lighter into a blowtorch.

Cat. TS-1680
Was $29.95 Save $10.00
Now $19.95

6 SECTOR ALARM DEAL

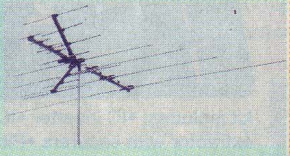
Ideal for larger homes. This system has our 6 sector panel and includes everything that a professional alarm installation company would install and charge around 800-$1000. Save a fortune by doing it yourself.

INCLUDES:	NORMAL PRICE
1 x 6 sector Jaytech panel	$139.50
1 x mains power supply	$21.50
1 x 1.2Ah backup battery	$28.50
3 x Jaytech pulse count PIRs	$89.85
3 x reed/magnet switches	$17.25
1 x strobe	$19.95
1 x metal siren cover	$28.95
1 x siren horn	$25.95
1 x internal siren	$19.95
2 x deterrent stickers	$4.00
100 m of 6 core alarm cable	$88.00
NORMALLY PAY	$483.40

Cat. LA-5455
Was $349
Feb. $319
Save $30

TV ANTENNA MADNESS

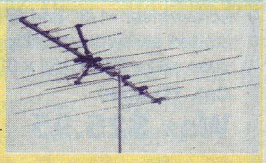
TRIBAND



An excellent antenna for medium signal reception areas with moderate signals. Receives FM, VHF and UHF band 4 (channels 21-35). Either horizontal or vertical mount, corner reflectors provided for improved UHF performance. Balun supplied for coax.

Cat. LT-3145 Was $119 Feb. $99 Save $20

SUPER GHOSTBUSTER



This 'Top of the line' UHF/VHF TV antenna will really drag in those signals. Suitable for VHF 0 - 11 and UHF band 4 (SBS). Corner reflectors provided for improved UHF performance. Provision is made for either horizontal or vertical installation. Balun supplied for coax. Suitable for all Australian capital cities. High gain with reflector for fringe areas. Powdercoat boom with insulators.

Cat. LT-3151 Was $139 Feb $119 Save $20

600W DC - DC CONVERTER KIT FOR POWERING AUDIO AMPS IN CARS

This kit can power up to two 300W audio amp modules, or lower - power modules with a trimpot adjustment! Output voltage is +/- 70VDC max., so you can run two of our 320WRMS into 4 ohm amp kits (KA-1771) for a thunderous 600W RMS of power! Kit is supplied short form with PCB, cooling fan, heatsink, gold fuseholder and fuse plus all electronic components. High quality machined pin IC skts supplied free!

Cat. KC-5212
Was $329
Save $40
Feb. $289

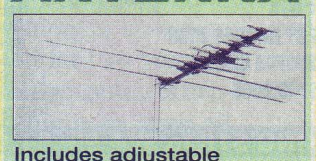
8 CHANNEL STEREO MIXER KIT

REF: SILICON CHIP NOV + DEC 1996. This new design from Silicon Chip is easy to build and features the latest low noise op amps and circuit design. Included are 8 main input channels, an auxilliary input channel, LED bargraph level meters, effects send and return loop plus comprehensive monitoring facilities. This mixer is ideal for home studio/ multimedia production, band work plus P.A. applications in schools, churches, halls etc. Other features include: stereo outputs, channel panning, separate bass and treble, balanced inputs using 6.5mm phono or XLR, balanced stereo out, plus monitor outs for headphones and foldback. Construction has been refined to just one main PCB and a small power supply PCB. As all input/output sockets and switches are PCB mounted there's no complex wiring required making this mixer a breeze to construct! The mixer kit is supplied with PCB and all on-board components and hardware including pots and knobs. A low radiation torroidal transformer and power supply components are also supplied. A professionally punched and silkscreened front panel is available separately. A punched and zinc passivate coated chassis is also available separately. See Silicon Chip Nov for full specs.

MIXER KIT	Cat. KC-5214	$399
SLOPING CHASSIS	Cat. KC-5216	$139
FRONT PANEL	Cat. KC-5215	$99

NEW

UHF/VHF HOME OR CARAVAN ANTENNA



Includes adjustable polarisation, lightweight, anodised, 3 year warranty. See catalogue page 140.

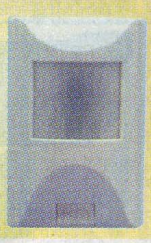
Cat. LT-3176
WAS $77.95 SAVE $18
FEB $59.95

BUY 10 LESS 10%

Bellmate PIR

Pulse count, 24 element, 000's sold. See cat page 151.

Cat. LA-5016
Was $39.95
Feb. $35 Or 5 for $165
Save $4.95



APOLOGY

In our January Ads we advertised a JUMBO 2100mAH MICROTEC BATTERY for $49.95. Unfortunately this price was incorrect - the correct price is $79.95. We apologise for inconvenience caused.

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRON
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MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

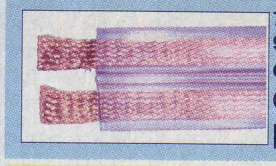
METEX M3850 COMPUTER CONNECT DIGITAL METER

Features include: •Dual display •R5232 interface •Transistor •Capacitance •Auto hold •Data hold •10 memory •Bargraph •Mix/max display •Relative offset •Logic •20A •4000 count •Backlight •Temperature •40mHz frequency •Auto/manual range. Supplied with: •Carry case •R5232 lead •Software on 3.5" disc •Leads •Instruction manual. Note: Current model does not have an inbuilt temperature probe. See 96 Cat, page 28 for full details.

Cat. QM-1260 **Was $239.50**

February $199.50 Save $40.00

OFC SUPER FLAT SPEAKER CABLE



7 x 48/0.10mm. OD 11 x 2 x 11mm. See 96 Cat, page 119 for full details.

Cat. WB-1738

Cat Price $5.95 mt.

Feb Sale $3.50 mt.

30M ROLL 75Ω CABLE

3C2V light duty coax. Black in colour.

Cat. WB-1999 **Cat Price $16.95**

Feb $10 Save $6.95

RECORDABLE CD's

Quality KAO Brand.

Cat. XC-4710

Feb $20

10 For $175.00

COMPUTER SWITCH

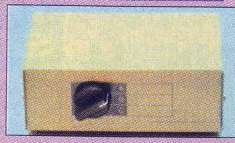
2 WAY D25 SERIAL TYPE IN METAL BOX

Cat. XC-5062

Cat. Price $24.95

Feb $12.50

1/2 Price



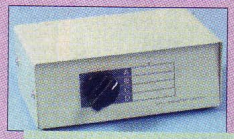
4 WAY D25 SERIAL TYPE IN METAL BOX.

Cat. XC-5071

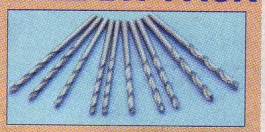
Cat. Price $49.95

Feb $20.00

Save $29.95



DRILL BIT PACK



Includes: 1x3.0mm 3x3.5mm 2x4.0mm 4x3.175 mm (1/8')

Cat. TD-2405

Cat Price $14.95

Feb $8.95

Save $6.00

REED RELAY BARGAIN

SPST 12V magnetic shielded . •2.54mm •nom volt: 12VDC •coil resistance: 1050Ω •nom input power: 138mW •must operate volt: 8VDC •must release volt: 0.8VDC •max voltage: 22VDC •case size: 22.8(L)x8.7(H)x8.8(W)mm.

Cat. SY-4035 **WERE $2.00ea**

Now $1ea or 10 for $5

MICROPHONE CABLE

Single core, black PVC with cotton filler. Size 14 x 0.18mm. Conductor OD 4.6mm

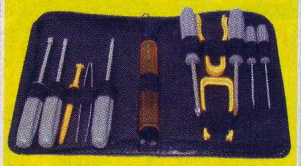
Cat. WB-1520

Was $1.70mt.

$166 per 100mt. roll.

Feb. $65 Roll or $1 per mt

COMPUTER SERVICE TOOL KIT



kit includes: •IC inserter •IC extractor with securers •Pin vice •Tweeters •1/4", 3/16" nut screwdriver •T15 torx screwdriver •Parts tube for storage •#1 and #0 Philips screwdriver •1/8" and 3/16" slotted screwdriver •Zipper case •Size 220 x 155 x 38mm

Cat. TD-2040

Was $25.95

Feb. $16.95

Save $9.00

RF SIGNAL GENERATOR

Cat. QT-2312 **Was $289**

Feb. $229 Save $60

AUDIO GENERATOR

Cat. QT-2310 **Was $289**

Feb. $229 Save $60

See 96 Cat P32 for details.

BUY BOTH FOR $439

HOBART STORE OPEN 9-4 SATURDAY

AMAZING BARGAIN WORLD TRANSISTOR COMPARISON TABLES

1/2 PRICE

Vol 1 (A-Z)

This comparative data book (Vol 1) contains more than 11,000 different transistors and FETs all of which are listed alphabetically. Each page is divided into 3 sections:- The description part with the columns - type, material, polarity and desc of application. The data part with the most important ratings, divided into clear columns, and a drawing of the corresponding case with the connection sequence. The alternative - type part, listing, as far as possible, the most suitable alternate types. Softcover. 270 pages. 215 x 147mm.

Cat. BM-4584 **Was $18.95**

Vol 2 (O - μ)

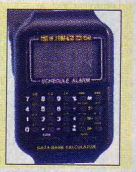
This volume contains more than 15,000 devices. It includes 2N, 2SA, B, C, D, 2SK, J Mosfets and more. Softcover. 430 pages. Size 215 x 147mm.

Cat. BM-4585 **Was $18.95**

BUY VOL. 1 & 2 FOR THE PRICE OF 1

$18.95 FOR VOL1 & 2

DATABANK CALCULATOR WATCH



Three line databank which will store about 50 names and phone numbers - 1.4k memory - secret lock function - 5 tone. Up to 10 alpha characters and up to 20 numerals.See 96 Cat, page 169 for details of this amazing watch.

Cat. XC-0260

Was $19.95 **Feb $12.95** Save $7

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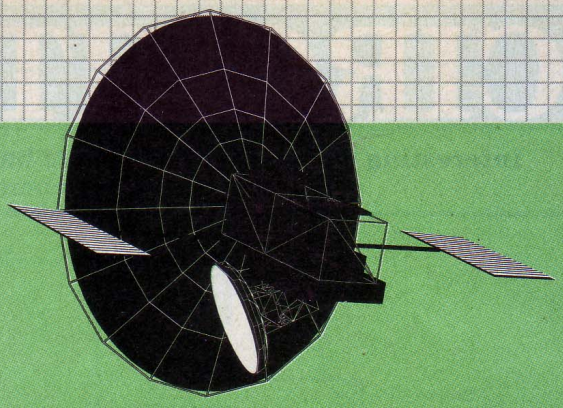
SATELLITE WATCH



Compiled by GARRY CRATT*

Apstar 1A, 134°E longitude:

The location of Apstar 1A has angered Indonesian satellite operator Pacifik Satelit Nusantara, who claim to have registered the orbital location in 1993 for their Palapa Pacific 1 satellite. The company intends to make a formal complaint to the ITU. As has been demonstrated in the past, orbital location conflicts are becoming more common with the squeeze for spots over Asia. Indonesia has been testing a new ground station, causing interference to the Apstar signal.

Asiasat 2, 100.5°E longitude:

The Egyptian Telecommunications Union has signed a multiple year lease for one 36MHz transponder on this satellite for the provision of Arabic language (and others) throughout the Pacific. The transponder should be operational by the time this column goes to press.

Elsewhere on AS-2, the final participant in the European bouquet, Italian broadcaster Rai International commenced operation in early November. The 5-channel digital TV service is now fully loaded and carries German, French, Italian, Spanish and the European music channel MCM, as well as 10 European radio stations.

A further addition to this package is the projected feature of a 1-way Internet browser, to the Deutsche Welle service. By tuning a digital satellite receiver to the signal and through the addition of a simple decoder box between receiver and computer, selected Internet sites can be downloaded at up to 255kbp/s, a significantly better rate than through a telephone line.

The service is due to commence on Asiasat 2 in March, following successful trials on some of the Deutsche Welle analog satellite channels in Europe and the USA. A 2.3m satellite dish is required for the reception of this digital package, in both Australia and New Zealand.

Panamsat 2, 169° E longitude:

Chinese Television Corporation (CTN) has announced it will use this satellite to transmit news feeds from within Taiwan, Northwest Asia and the Western USA to studios in Taipei.

Use of the transponder should commence early in February. Few analog transponders remain on this satellite (CNN, NHK, TVSN), as Panamsat has elected to adopt the Scientific Atlanta MPEG PowerVu compression system exclusively, when a digital platform is required. The proprietary S/A PowerVu system is not immediately capable of receiving DVB compliant MPEG-2 signals.

Gorizont 30, 142.5°E longitude:

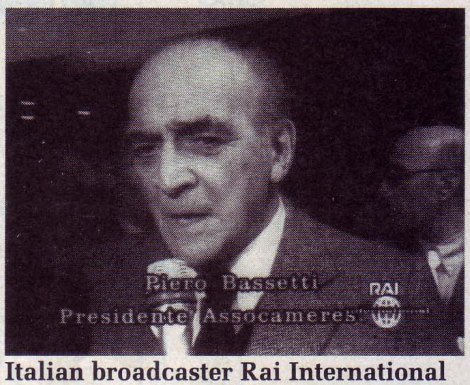
Papua New Guinea broadcaster EM TV has now adopted Videocrypt full time, based on observations made during December last year. The motive for scrambling all programs (even four hours of test pattern every morning) remains unclear as the broadcaster had advised they would be scrambling selected programs only, to prevent unauthorised re-broadcasting.

Tamil broadcaster "Raj TV" has now disappeared from this satellite. Many operators have shown concern at the increasing degree of orbital inclination of this class of Gorizont satellite.

Equipped with only north/south attitude correction, geostationary operation can only be guaranteed for two years or so, before inclined orbit operation is necessary. The effect of this is to force all ground stations to adopt dish tracking which is often not practical. No doubt EM TV will be faced with the decision to "ytrack" or change satellites during 1997.

Gorizont 29, 130°E longitude:

Although reported as being sold to a consortium in the Philippines and to be used for coverage of the Asia Pacific Economic Forum held in Manilla in November last year, the satellite remained on station at 130°E instead of being moved to 153°E as previously advised.



Italian broadcaster Rai International commenced operation on Asiasat 2 in early November.

All television broadcasts on this satellite have ceased and the fate of the satellite, which still has several more years of active life (in an inclined orbit) remains unclear.

Optus B1, 160°E longitude:

Sky network New Zealand will commence their long awaited satellite pay TV service in April. Initially, it will be operated in analog using Videocrypt scrambling (the same system used on the Sky network terrestrial pay TV system in New Zealand).

As deregulation of the pay TV industry will occur on July 1 this year, the service could be available in Australia almost immediately after commencement.

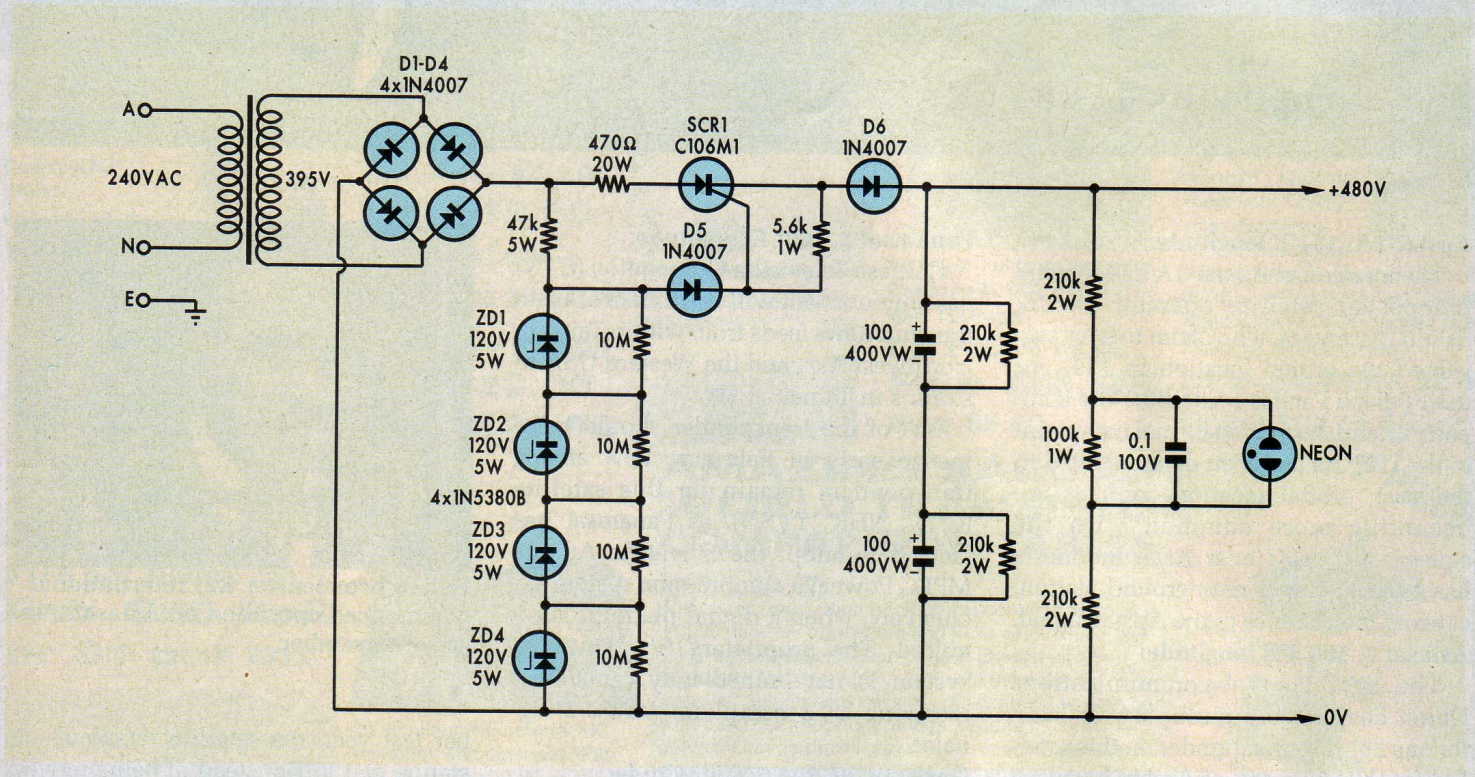
Measat 2, 148°E longitude:

First signal reports of testing on this satellite were received in December last year. By the time this column goes to press, C band signals should be observable along the east coast of Australia. **SC**

* Garry Cratt is Managing Director of AvComm Pty Ltd, suppliers of satellite TV reception systems. Phone (02) 9949 7417. http://www.avcomm.com.au

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



AC power supply for photographic flashgun

This circuit has been used to power a professional flashgun of about 200 joules. It has capacitors of 1500µF rated at 500V with a maximum surge voltage of 530V.

The power supply delivers a regulated 480V to the high voltage capacitors and allows for mains variation of ±9%. An Arlec transformer which had two secondary windings of 12.6V @ 3.5A on a segmented bobbin was rewound to provide a secondary voltage of 395V AC.

A full-wave rectifier gives positive half sinewaves of 560V peak and these are truncated at 480V, using four 120V zener diodes in series. This zener-regulated voltage is applied via diode D5 to the gate of SCR1.

The SCR fires every time its gate is higher than the cathode by about 0.6V. The resultant pulses charge the capacitors until they reach 480V and then the SCR stops conducting and then fires intermittently to maintain the voltage. The fluctuation appears to be around ±1V.

A neon lamp was used as a flashing "ready" indicator. It fires at around 85V and drops to 62V while conducting. This range is increased by the divider action and was deemed unsatisfactory. A 0.1µF capacitor was connected in parallel with the neon, transforming it into a relaxation oscillator. Every time the capacitor reaches the firing voltage of the neon, it fires and discharges the capacitor. The cycle is repeated while ever the supply is above 450V. This is adjusted by the 100kΩ resistor (in parallel with the neon).

The 470Ω 20W resistor limits the current charging the capacitors when they are fully discharged and naturally affects the time taken to reach full voltage. The system takes about six seconds to recharge the capacitors after each flash firing. When the flash extinguishes the capacitors still have about 100V when starting to recharge.

The SCR is protected by diode D6 when the AC is switched off and the capacitors are still charged.

Many modern flashguns of this capacity operate at 350V and the supply should be modified accordingly.

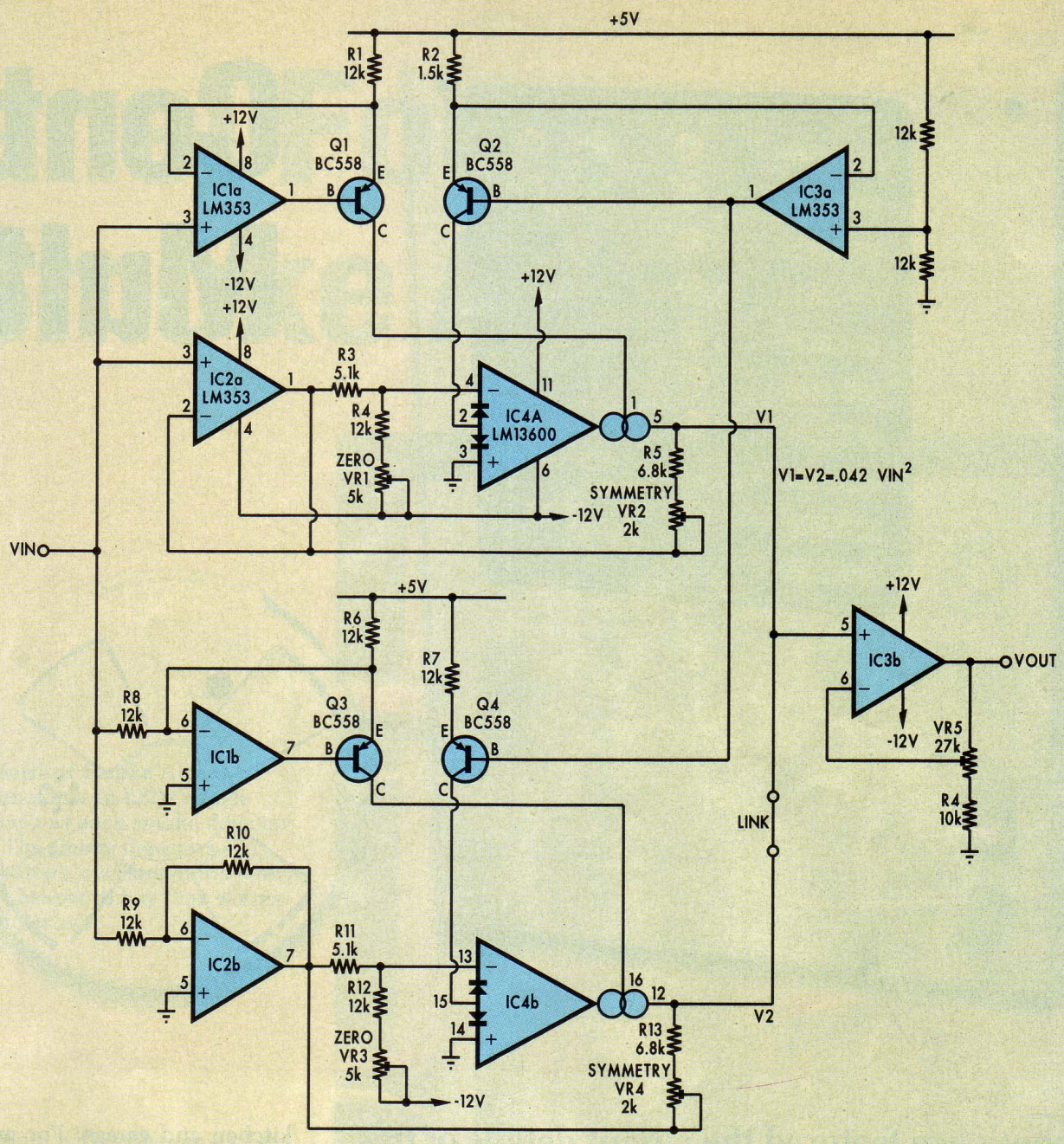
Warning: this high voltage supply is potentially lethal. Only experienced persons should attempt to build it.

V. Erdstein,
Highett, Vic. ($40)

Precision analog multiplier

The National Semiconductor LM-13600 and LM13700 ICs, known as "dual output transconductance amplifiers" differ from ordinary IC amplifiers in two main respects. First, they produce output currents instead of output voltages and second, their gains (gm) are variable as functions of input (control) currents.

These properties make these ICs useful in applications such as voltage controlled amplifiers and filters, automatic gain control (AGC) amplifiers and voltage multipliers. Examples of the latter include RMS voltmeters,



power meters and watt-hour meters.

One problem with these ICs is that the relationship between gain and input control current is not perfectly linear over their entire operating ranges. In some applications this may not be a serious problem but if these ICs are to be used in precision applications then it could be significant. That turned out to be the case with a project which was intended to measure the energy in high voltage pulses.

The design concept involved using one of the two amplifiers in an LM13600 to generate an output voltage proportional to the square of an input pulse voltage. This voltage could then be integrated using an ordinary op amp to obtain the pulse energy. The circuit used was a "four quadrant multiplier" and was an adaptation of a circuit in the National Semiconductor data sheets for this device.

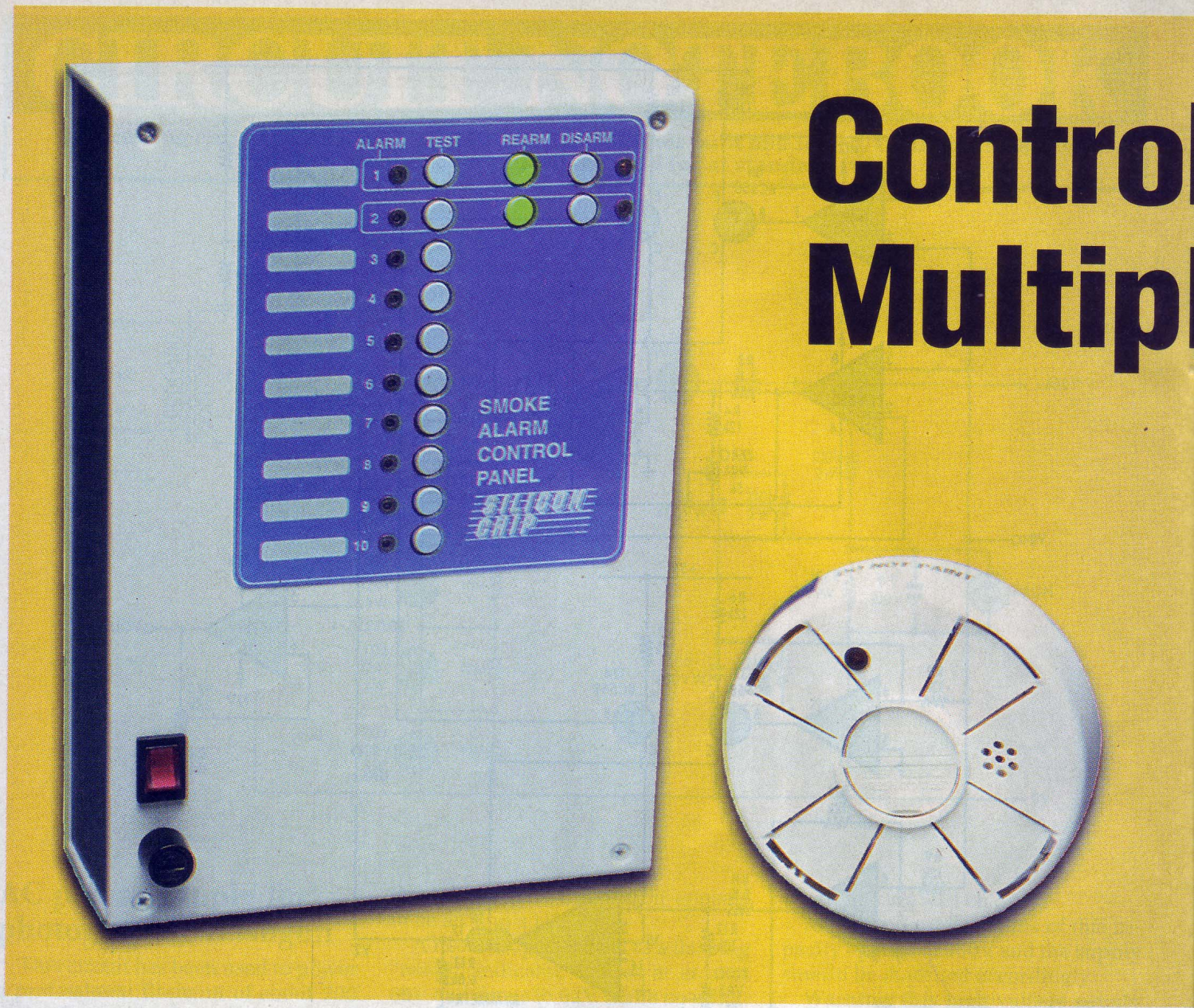
The problem showed up as an asymmetry in the output waveform for the positive and negative halves of a sinusoidal input. The degree of asymmetry in the waveform began to be significant for output voltages outside the range of 0-200mV peak-to-peak. This effectively limited the basic operation within this range since gain symmetry was a critical requirement.

The non-linearity problem was solved by a cancellation method: two identical circuits were set up but with the signal into one reversed in phase with respect to the other and the outputs of the circuits were combined, as shown in the accompanying circuit.

In this mode of operation, the output waveform was symmetrical over the range of 0-3V peak-to-peak (a 15:1 improvement over the basic circuit). Also, the output distortion at frequencies above 10kHz was significantly reduced at all signal levels. The circuit is usable for input signals up to 200kHz.

Herman Nacinovich, Gulgong, NSW. ($50)

Contro
Multip



Last month, we featured the circuit details of this Smoke Alarm Monitor. It will control up to 10 smoke detectors with the ability to disarm and automatically rearm two detectors so you can cater for childrens' parties, candlelit dinners and open fires in the winter. This month we give the construction and installation details.

Based on cheap and readily available ionisation smoke detectors, this Smoke Alarm Control Panel solves the problems of maintaining continuous monitoring of up to 10 smoke detectors. Why 10? As outlined in last month's article, if you have only one or two monitors in the typical Australian home, you are not safe against fire. Fire could start in a room with a closed door and even if a smoke detector is ultimately triggered it may be too late to save your home or your life.

As noted last month, you need a smoke detector for every bedroom which has any electrical equipment plus a detector for every other room with electrical gear, apart from the kitchen and garage. For more information along these lines and the circuit description, you will need to refer to last month's issue.

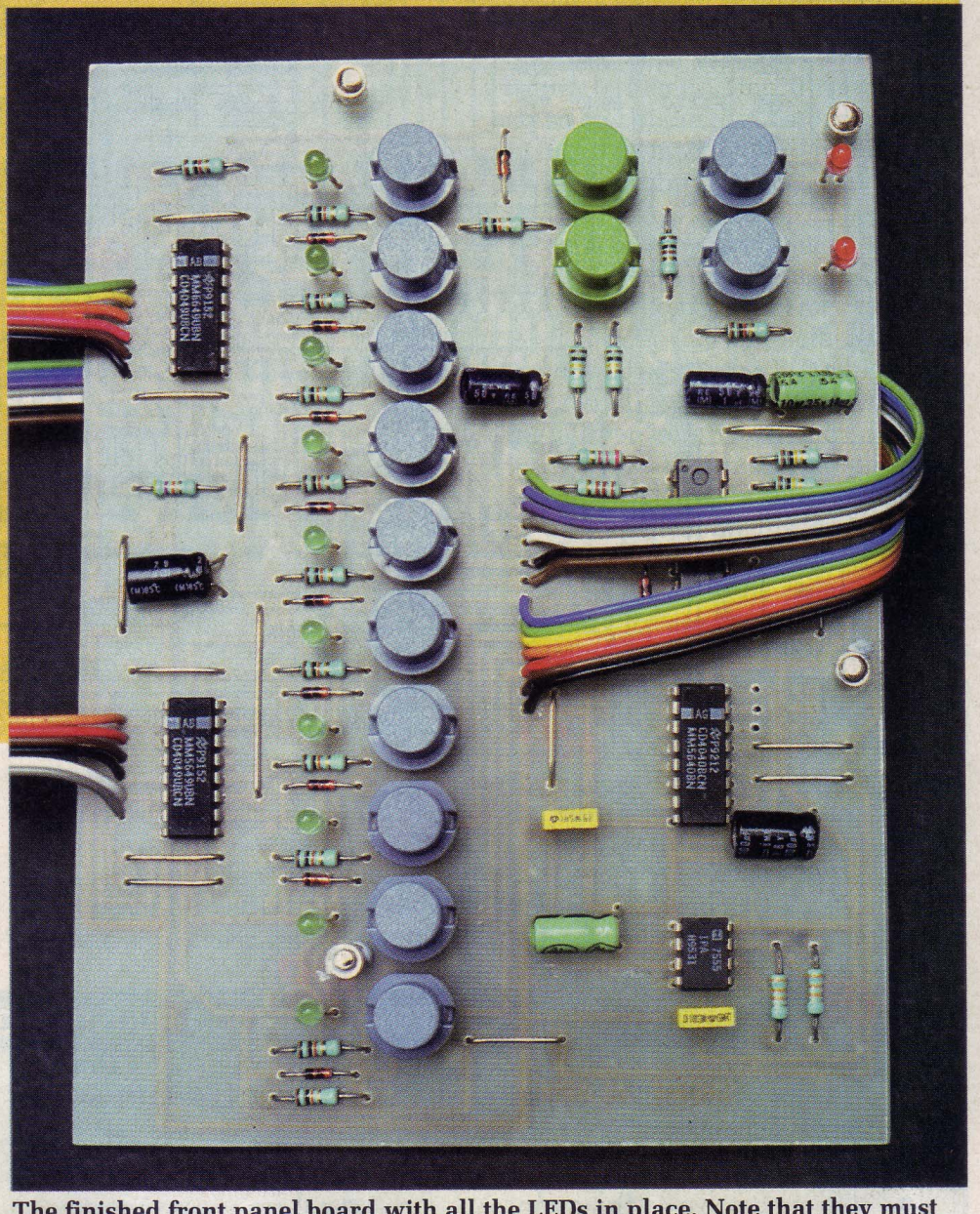
In setting out the construction details, we will first discuss the assembly of the Control Panel and then continue with the modification of standard smoke detectors which are available from any hardware store or supermarket. Finally, we will discuss the installation of a typical home system.

Control panel assembly

The SILICON CHIP Smoke Alarm Control Panel is housed in a plastic case measuring 180 x 260 x 65mm. This would normally be mounted on a wall and so the top cover of the case becomes the control panel. We fitted

Panel For e Smoke Alarms

PART 2:
By JOHN CLARKE



Left: the finished Smoke Alarm Control Panel has 10 LEDs which cycle through as each smoke detector is polled. The smoke detectors are modified battery operated units which are much cheaper to buy than mains-powered detectors.

The finished front panel board with all the LEDs in place. Note that they must be test-fitted in the front panel before they are soldered.

our prototype with a Dynamark label measuring 127 x 144mm.

Inside the case, the circuit components are mounted on two separate PC boards. The main board measures 149 x 251mm and is coded 03312961. It is installed in the base of the case and has a number of multi-way terminal connectors for all the connections from the smoke detectors. Two large holes at the top of the main board are for cable entry for the smoke detector wiring, although these may not be used if the cables are brought in via one of the side panels.

The second board measures 112 x 151mm. It is coded 03312962 and it carries all the LED indicators and pushbutton switches for the smoke detectors.

Before you begin assembly of the PC boards, check each one for shorts between tracks or breaks in the copper pattern. You may need to drill out some holes for mounting the PC boards, the transformer, REG1 and for cable ties to hold down the SLA battery. The component overlay for the main board is shown in Fig.1 while the second board is in Fig.2.

Install all the links first and note

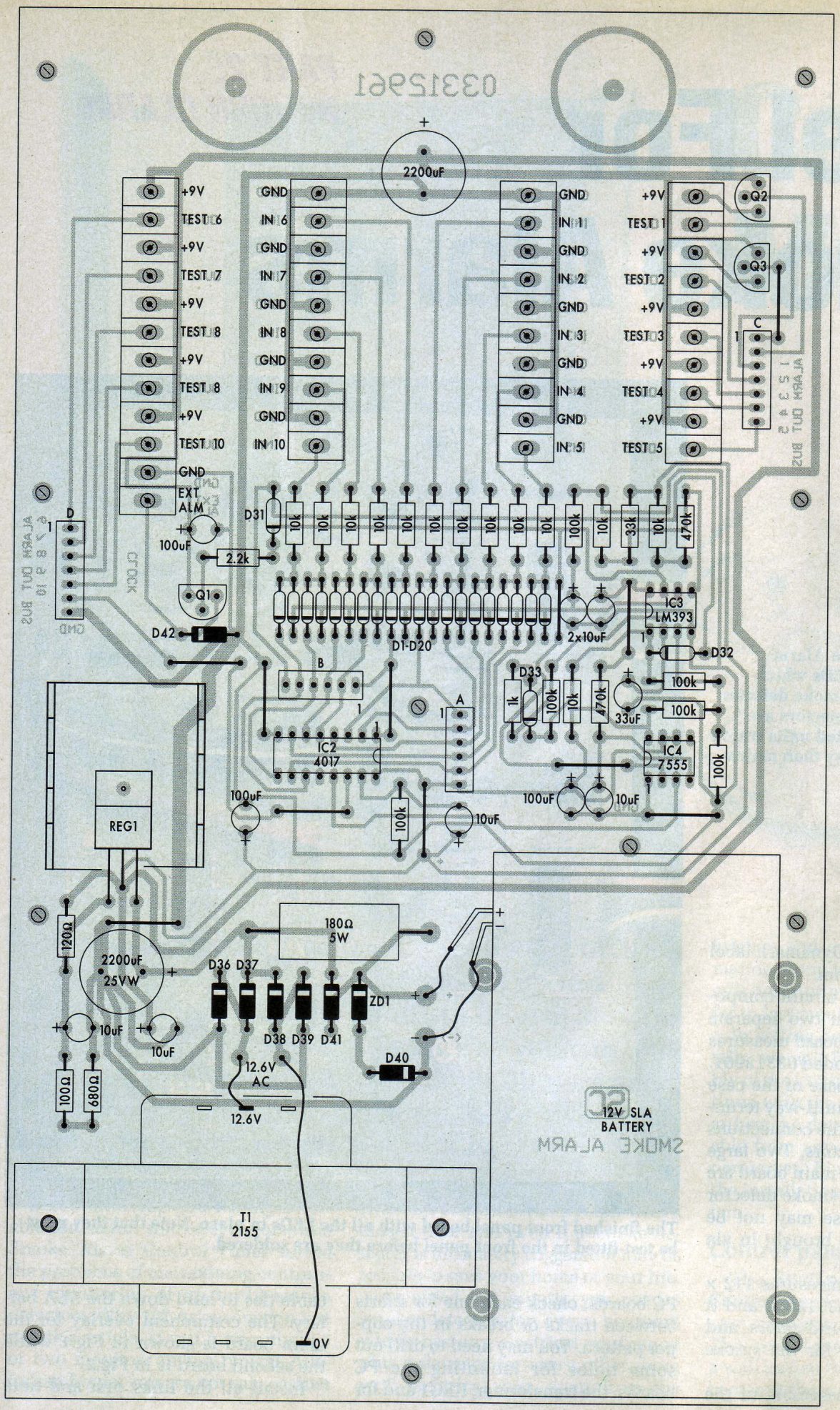


Fig.1: this is the parts layout for the main PC board. Take care to ensure that all polarised parts are correctly oriented and note that a heatsink must be fitted to REG1. The 12V SLA battery is secured to the board using two plastic cable ties.

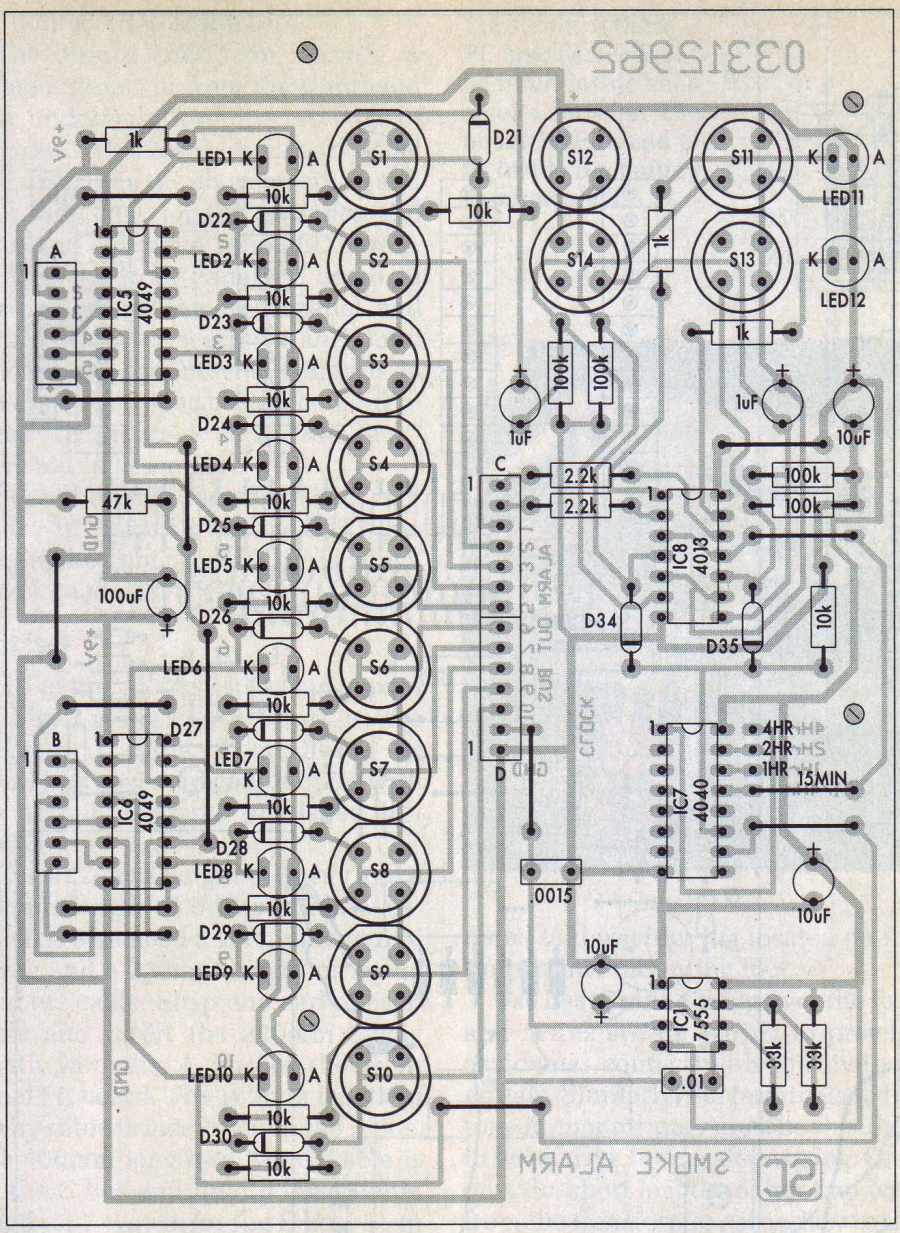


Fig.2: the component overlay for the front panel board. This board mounts face down into the front panel.

that you must choose the appropriate link for the preset disarm period you require. Fig.2 shows the link for a 15-minute disarm period although we suggest that most people will want a longer delay – the choice is yours.

Next, install the resistors, using the resistor colour code table as a guide to the values. Alternatively, use a digital multimeter to check each resistor before it is installed. This done, insert the diodes, taking care with their orientation. Note that diodes D1-D20 (see Fig.1) are installed with their cathode bands facing IC2. Similarly, on the second board, diodes D22-D29 are all oriented the same way, with their cathode bands away from the switches.

Note that there are two types of diode used on the main PC board: 1A 1N4004s which have a black body and the smaller 1N914s which usually have an orange glass body. The 13V zener diode ZD1 is similar in size to the larger diodes so be careful to install it in its correct place.

Five PC stakes are installed on the main PC board. Four of these are for the transformer secondary and the SLA battery terminals. The fifth is mounted at the end of the SLA battery position to stop it from moving along the board and encroaching on adjacent capacitors.

Next, insert and solder in the ICs. Take care with the orientation of each and check that the correct type has been installed before soldering. The 3-terminal regulator REG1 is mounted horizontally on a small heatsink using a 3mm screw and nut. Bend its leads so that they insert into the holes provided. There are three transistors to be mounted on the main board; make sure they are oriented correctly.

Take care with the polarity of the electrolytic capacitors when they are installed. Note that the electrolytics on the front panel board are mounted horizontally to allow clearance between the board and front panel. Switches S1-S13 are oriented with the flat side towards the top edge of the board. We used grey switches for S1-S11 and S13. Green switches were used for S12 and S14.

When installing the terminal strips

RESISTOR COLOUR CODES – CONTROL PANEL

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	10	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	33kΩ	orange orange orange brown	orange orange black red brown
❑	25	10kΩ	brown black orange brown	brown black black red brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	1	680Ω	blue grey brown brown	blue grey black black brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

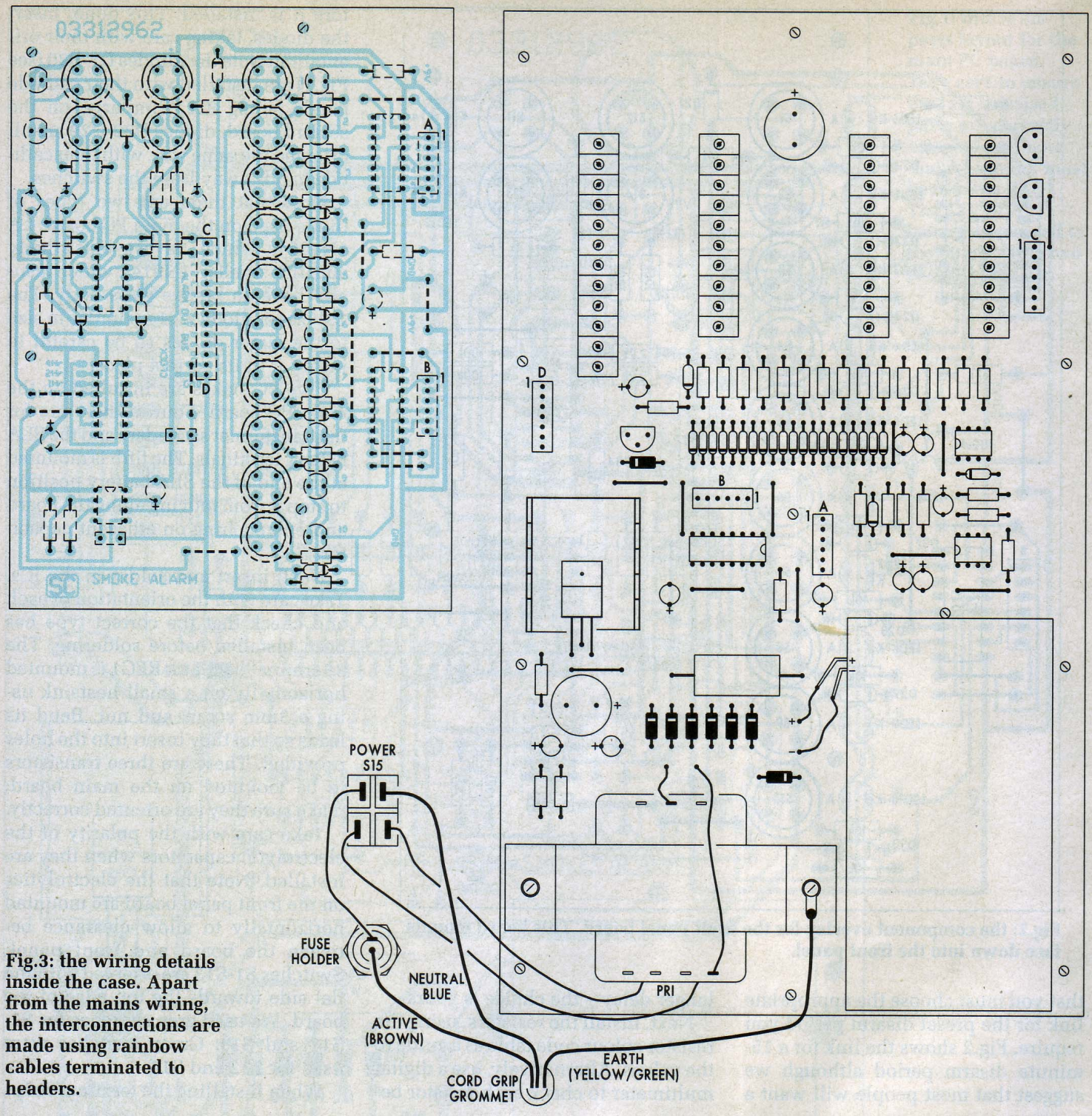


Fig.3: the wiring details inside the case. Apart from the mains wiring, the interconnections are made using rainbow cables terminated to headers.

on the main board, orient them with the wire entry side as shown on Fig.1. Also mount the 180Ω 5W resistor and the pin headers for the A, B, C and D connectors. If you use 8-way headers in the 7-way C and D positions, the end pin of each should be cut off.

Transformer T1 is mounted on the main board using 3mm screws and nuts. The earth solder lug is secured on the transformer mounting screw with a star washer and nut. The SLA battery is mounted on its side with the terminals facing the 180Ω 5W resistor. Secure the battery to the PC board using cable ties as shown.

Drilling the case

Because it is assumed that the Control Panel will be mounted on a wall, we have used the case unconventionally. The main board is mounted in the case lid (recognised by the brass inserts in the four corner posts), while the front panel is mounted in the base of the case. This has been done so that after installation, the lid can be removed by undoing the four screws.

You will need to drill a hole for the cord grip grommet adjacent to where the transformer will be positioned. The main PC board can be attached to the lid of the case using 3mm screws at the mounting standoffs.

The front panel section of the case will need to be drilled for the switches, LEDs and fuseholder. S15 and the fuseholder should be located 17mm in from the lefthand edge of the case to provide clearance for the transformer body. Position the fuse and S15 at 25mm and 55mm respectively up from

the bottom edge of the case.

The disarm LED11 for alarm 1 is located 22mm in from the righthand edge and 22mm from the top edge of the case. Attach the Dynamark label with LED11 in the above position and drill out holes for the switches and LEDs and insert the 3mm LED bezels.

Place the front panel PC board in position under the front panel and secure with 3mm screws and 6mm spacers into the integral standoffs in the case. (The spacers can be held in place over the screw using "Blu-Tack" as an aid in assembly).

Push the LEDs into the bezels and solder in place on the board. Then remove the front panel PC board which is now ready for wiring.

Wiring

All of the wiring details not shown on Fig.1 & Fig.2 are shown in the diagram of Fig.3. This should be closely followed, in conjunction with the circuit diagrams published last month.

Cut a 220mm length of 6-way and a 160mm length of 6-way rainbow cable. You also need a 400mm length of 7-way and a 250mm length of 7-way rainbow cable. Strip one end of each cable and insert the 220mm 6-way length into the A bus of the front panel PC board. The 160mm length of 6-way cable is inserted into the B bus. The 400mm length of 7-way cable is for the C bus and finally the 250mm length of 7-way is for the D bus. Strip the other ends of each cable of insulation and attach the header pins to each lead. Now slide the pins into the header shell and plug it into the main PC board.

Use 250VAC rated hook-up wire for the mains wiring. Alternatively, strip some wire out of the mains cord. The mains cord should be secured with the cordgrip grommet so that it cannot be pulled out of the case. The green/yellow striped wire should be soldered to the solder lug located on the transformer mounting foot.

Use heatshrink tubing over the fuse and mains switch wiring to prevent accidental contact with the live terminals. Similarly, the terminals to the transformer primary must be sheathed in heatshrink tubing after wiring. Connect the short lengths of hookup wire from the transformer secondary to the PC stakes on the main PC board.

The battery terminal wiring consists of short lengths of hookup wire with spade terminal clips attached to one end. Solder the free end to the PC stake on the board, taking care with the polarity when connecting to the battery.

Apply power to the circuit and check that there is about 9V between GND and the + terminal on the terminals strips. Initially, LED1 should light and then LEDs 2-10 should light in sequence, taking 7 seconds to cycle through. Press the disarm switches and check that the associated LED11 or LED12 lights. They should extinguish when the associated rearm switch is pressed.

If you find that the circuit does not operate as described, check that the rainbow connectors are terminated in the correct positions and with the right polarity. Also check the supply to all ICs. There should be 9V between pins 1 & 8 of IC1, IC4, IC5 & IC6; 9V between pins 16 & 8 of IC2 & IC7; 9V between pins 4 & 8 of IC3; and 9V between pins 14 & 8 of IC8.

Smoke detector PC board

The small PC boards for the smoke detectors can now be constructed. These measure 46 x 23mm and are

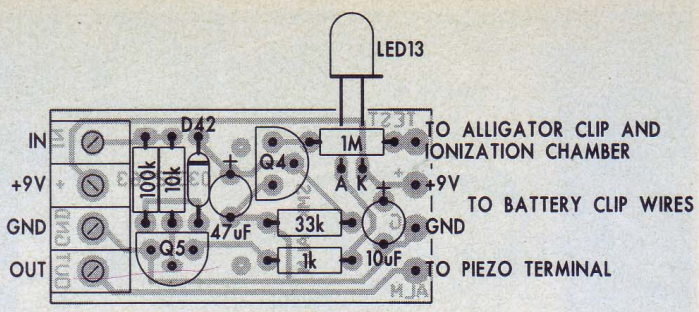
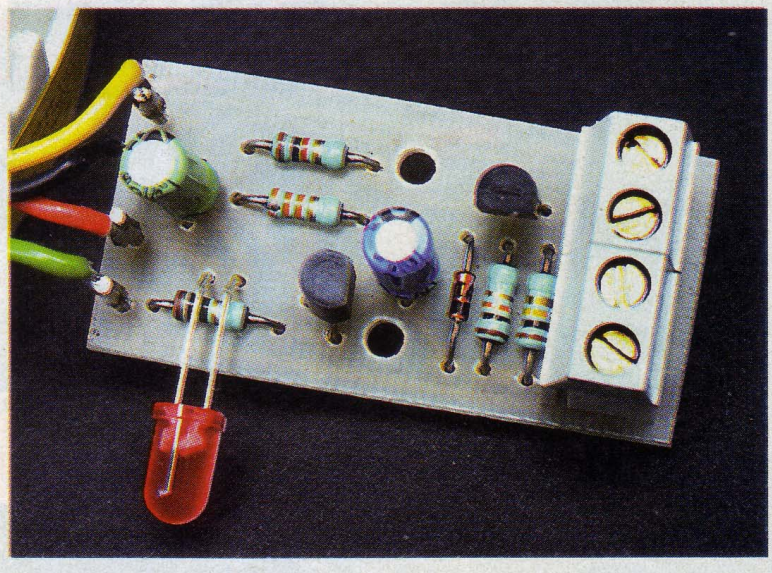


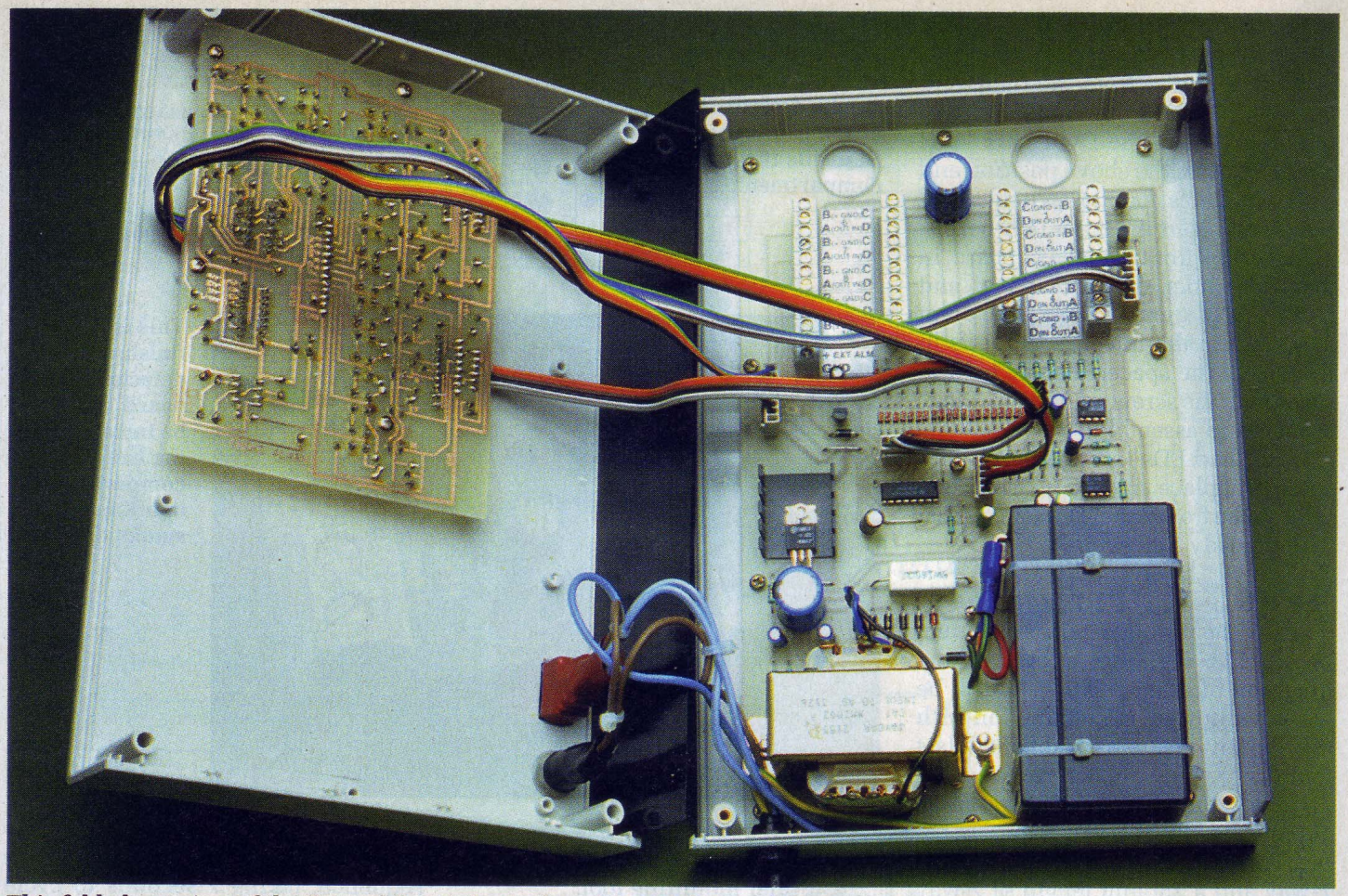
Fig.4: one of these PC boards needs to be fitted inside each smoke detector. The board is designed to fit inside the battery compartment.



This is a finished smoke detector PC board, about to be installed in the battery compartment of a Kambrook smoke detector.

RESISTOR COLOUR CODES – DETECTOR PC BOARD

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	1kΩ	brown black red brown	brown black black brown brown



This folded-out view of the Control Panel shows the wiring to the two PC boards. Take care to ensure that the mains cord is correctly anchored.

coded 03312963. You will need one of these boards for each smoke detector.

Install the five resistors and single diode and then the transistors; take care to use the correct type in each place. Insert and solder the four PC stakes on one end of the PC board and the 4-way terminal strip at the other end.

The capacitors are mounted as close as possible to the PC board with the polarity as shown. The LED mounts with its leads bent at right angles so that it protrudes above the edge of the board. We used Kambrook SD28 smoke detectors as our prototypes and the PC board is mounted with a self-tapping screw through the battery holder side panel as shown in the photograph.

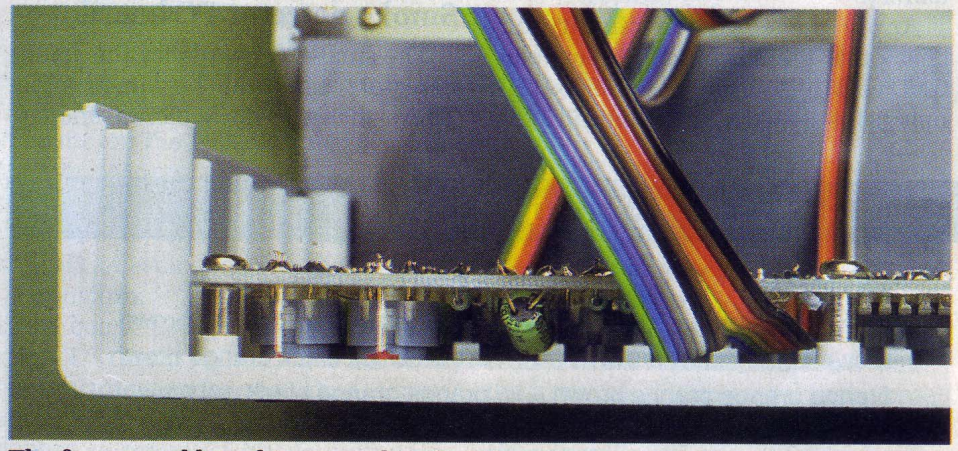
It should be possible to mount the PC board in the battery compartment of the smoke detector but the LED may need to be connected to the lid with flying leads in some cases.

Cut off the battery clip for the smoke detector and solder the supply wires to the + and GND terminals on the PC board. To make a connection to the ionisation chamber, we used an alligator clip soldered to a length of hookup wire. You can't solder to the ionisation chamber because it is stainless steel and you can't undo one of the screws because they are tamper proof. To make a secure connection, bend out one of the metal slots and attach the alligator clip to this.

On other smoke detectors it is possible to make a connection to a wire which is attached to the ionisation chamber.

Finally, attach a length of hookup wire to the piezo terminal which has a red wire from the smoke detector circuit already connected.

We drilled a hole in the side of the smoke detector case to allow access to the lower screw terminals on the add-on PC board. You may have to make a different arrangement for other models of smoke detector. We have produced a label to designate the external connections and a copy of this should be affixed to the terminal block in each detector.



The front panel board is secured to the lid on 10mm standoffs. It is linked to the main board using rainbow cables terminated in header plugs.

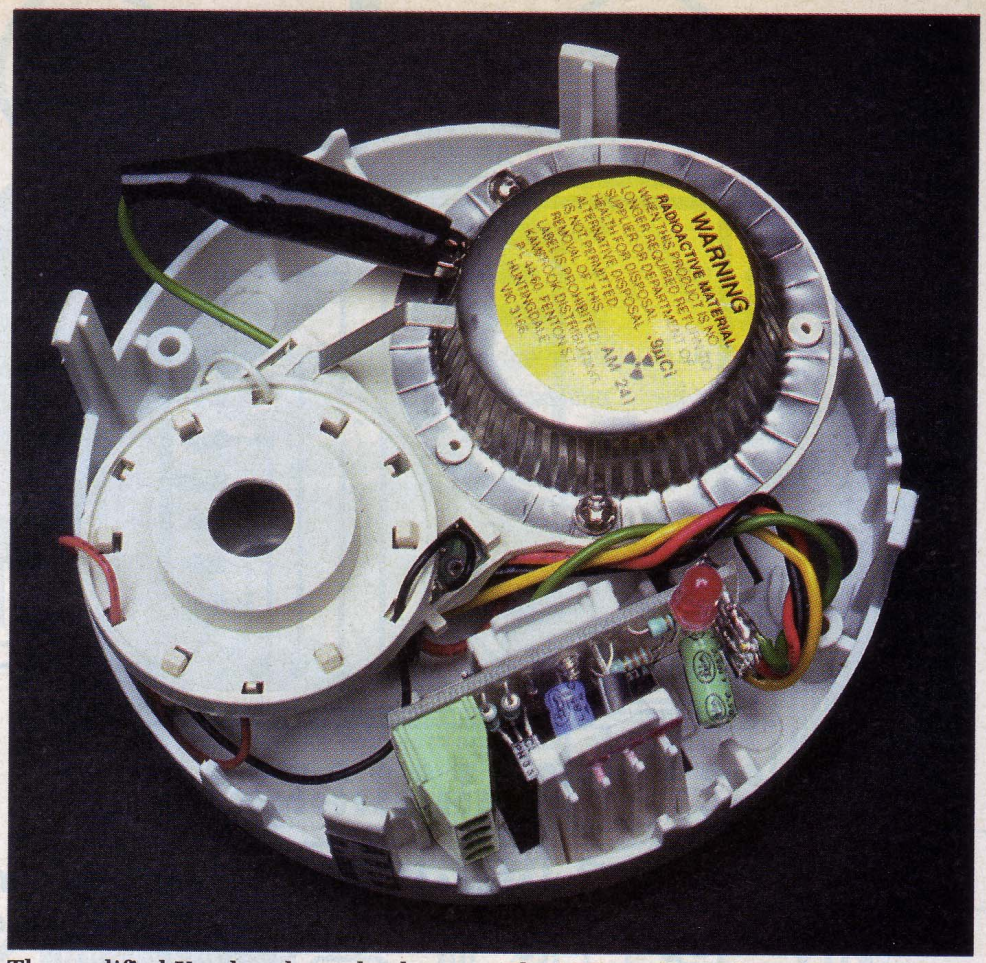
Drill a hole in the alarm lid for the LED bezel, taking care to mark the correct place before drilling.

Since the smoke detector has now been modified to be powered from an external source, there is no need to access it once it has been installed. We have produced a label which states that the are "No user serviceable parts inside". Copy as many as you need and affix them to each detector. This is to comply with Australian Standards AS3786-1993.

Testing

When you have finished modifying all the smoke detectors, they can be temporarily connected to the Control Panel. Make sure that the connections are correct before switching on power. Note that the "in" and "out" terminals on the smoke detectors connect to the "test" and "in" terminals on the control panel. To avoid confusion, they have also been labelled A and D. The A terminal (in) on the smoke detector should attach to the A terminal (test) on the control panel. Similarly connect the B to B, C to C and D to D.

Apply power and check that the LED in each smoke detector flashes about once every three seconds. Press the disarm switches to check that the



The modified Kambrook smoke detector. The LED on the PC board protrudes through the lid and flashes every three seconds as an indication that it is powered.

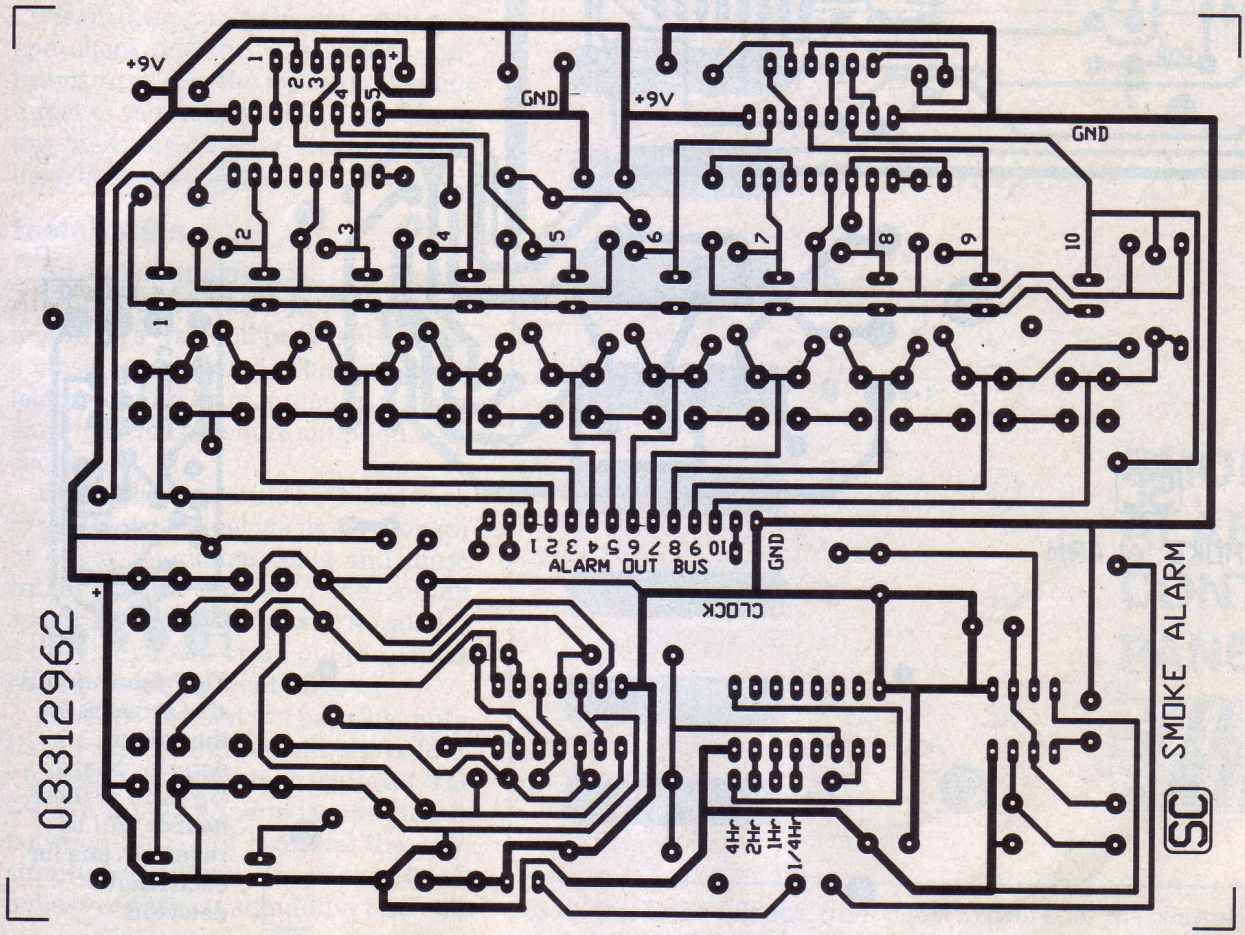


Fig.5: this is the full-size etching pattern for the front panel PC board. Once again, check the board carefully before installing any parts.

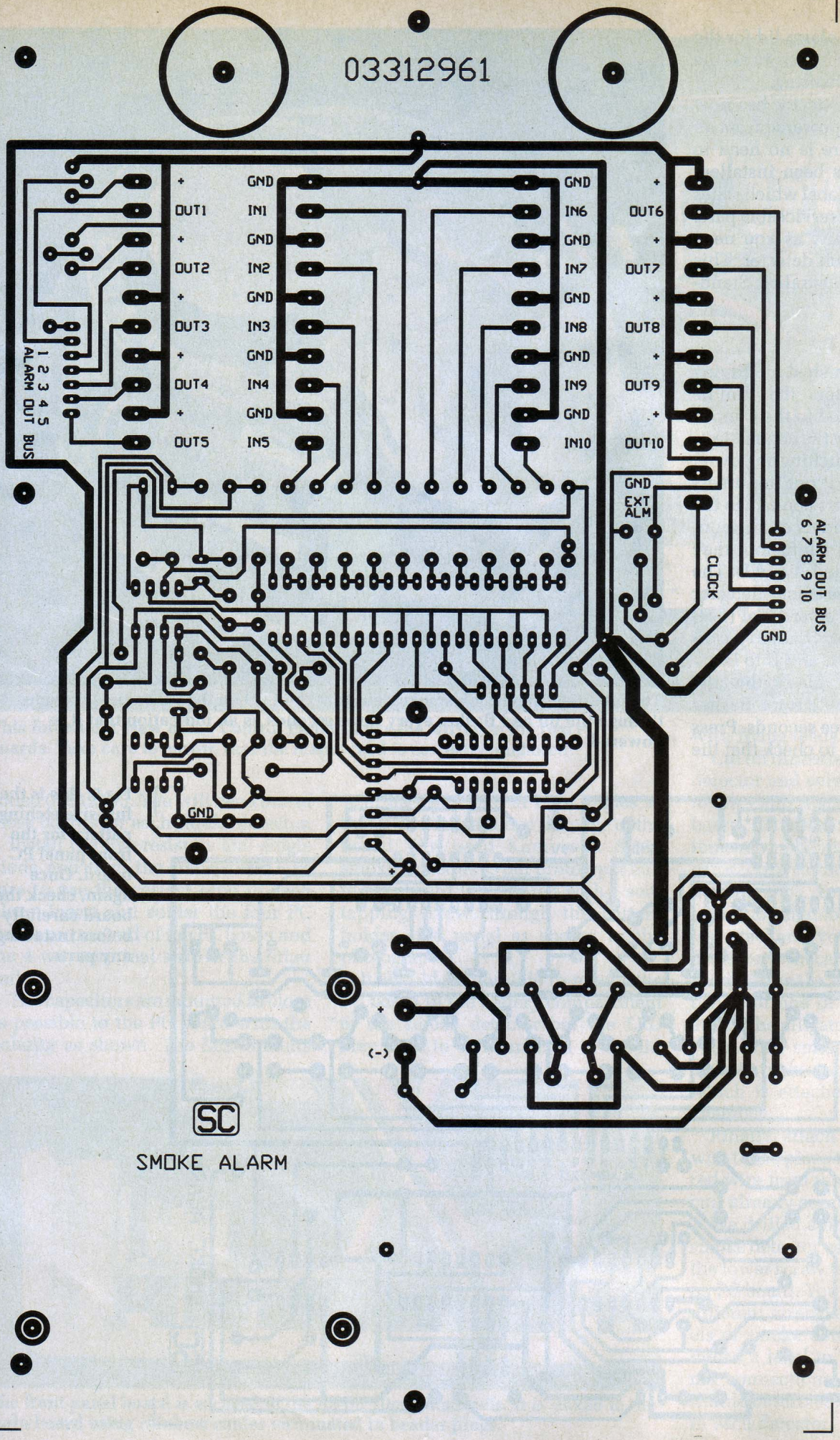


Fig.6 (left): this is the artwork for the main board, reduced to 70% actual size. It can be reproduced full size on a photocopier set to 1.41x.

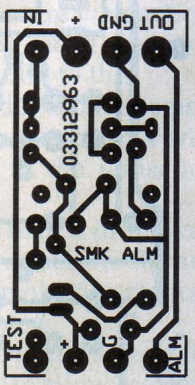


Fig.7 (above): full size artwork for the smoke detector board. Up to 10 of these boards will be required, one for each smoke detector.

No user serviceable parts inside

Fig.8: copy this label on a photostat machine and attach it to the outside of each smoke detector.

A	B	C	D
In	+	Gnd	Out

Fig.9: attach this label to the terminal block in each smoke detector.

LEDs for smoke detectors 1 and 2 stop flashing. Press the rearm switches to reapply power. Before proceeding further, use some "Blu-Tack" in the top of each smoke detector piezo siren to reduce the sound level.

Now press the test switch on the Control Panel for one of the connected smoke detectors. Its siren should sound after a few seconds and when the LED on the Control Panel lights, it should remain lit for about four seconds. The alarm will then stop and the next LED will light. During this 4-second time interval some of the other sirens may sound. Make this test on all connected smoke detectors.

If the test switch on one of the smoke detectors is pressed, then when the associated LED on the Control Panel lights (ie, when the detector is polled, all the other smoke detector alarms will sound.

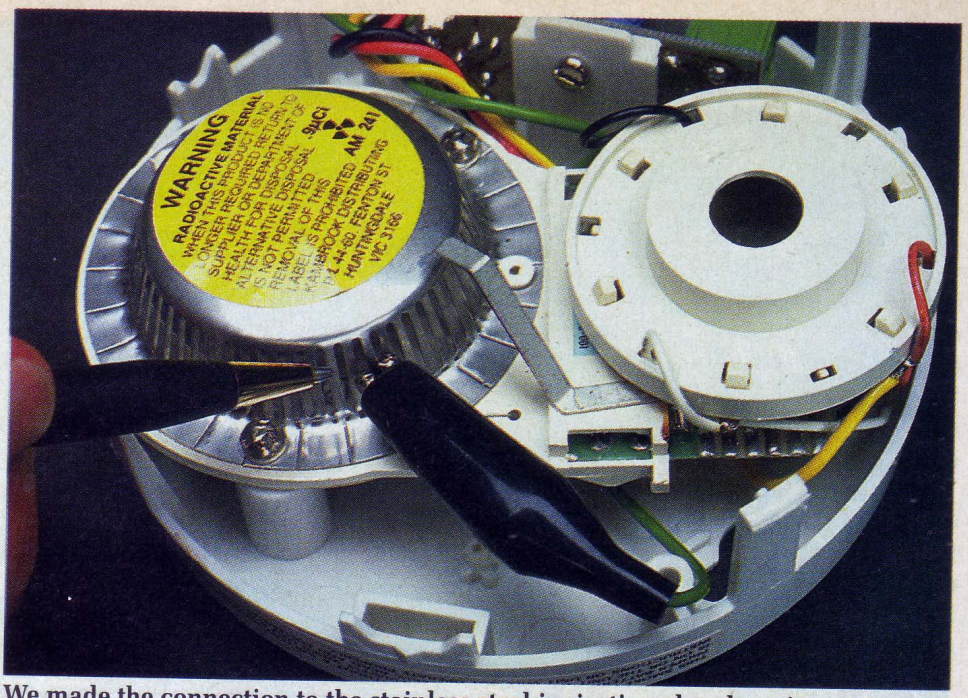
Next, disconnect the mains power and check that the SLA battery continues to power the circuitry. Do not forget to remove the "Blu-Tack" from the piezo sirens after all the checks have been completed.

Installation

As noted previously, the Smoke Alarm Control Panel is designed to mount on a wall and preferably inside a closet or cupboard. The smoke detectors should be mounted in accordance with the brochure supplied with each unit.

Each detector should be linked back to the Control Panel via its own length of 4-way telephone cable and these cables should all be in the ceiling space. After all, it would be no good if a fire started and burnt out the cables before the alarm went off!

Finally, note that the parts list published last month should show four 1kΩ resistors (not three), while a 47kΩ resistor should be added to the circuit between pin 11 of IC5f and the +9V supply. In addition, one of the 100µF bypass capacitors should be 10µF. SC



We made the connection to the stainless steel ionisation chamber via an alligator clip. Other smoke detectors are easier, as they have a wire connection to the chamber.

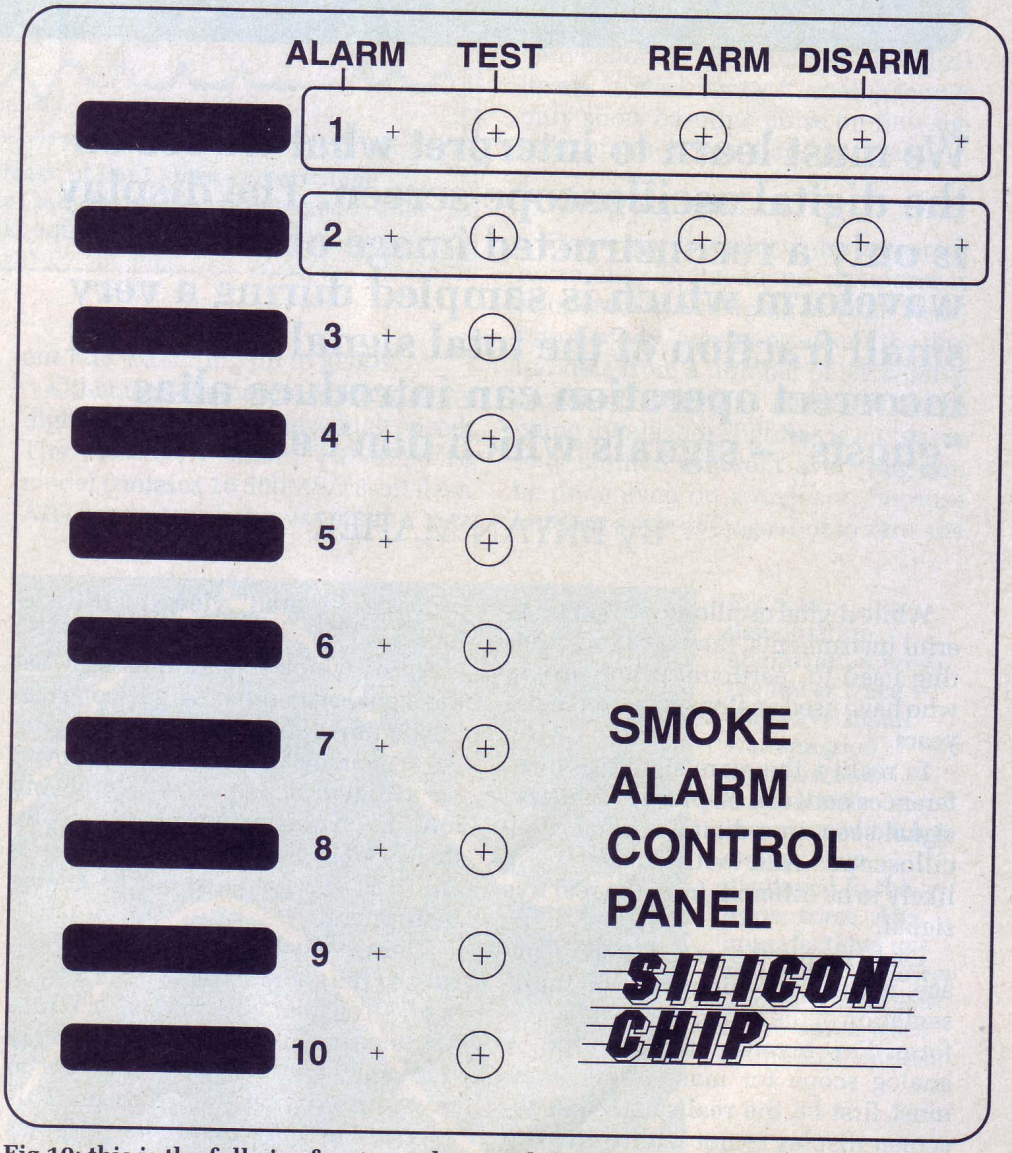
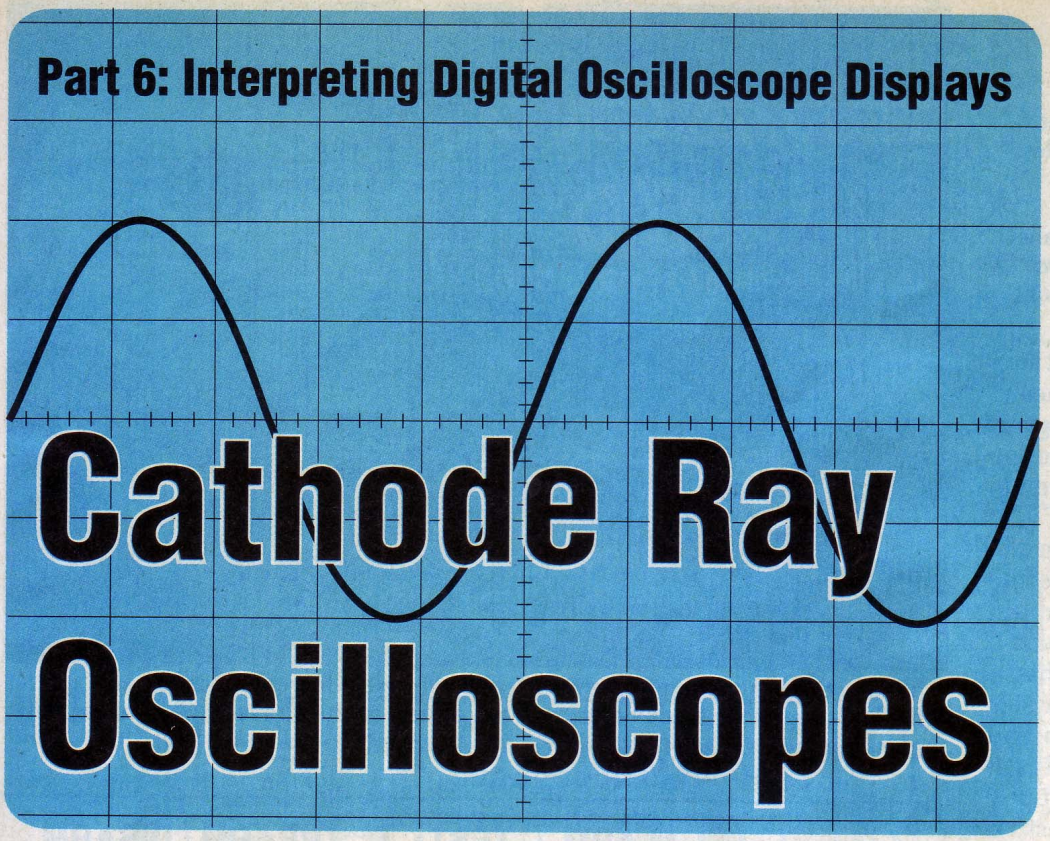


Fig.10: this is the full-size front panel artwork for the control panel.

Part 6: Interpreting Digital Oscilloscope Displays



Cathode Ray Oscilloscopes

We must learn to interpret what we see on the digital oscilloscope screen. The display is only a reconstructed image of the waveform which is sampled during a very small fraction of the total signal time. And incorrect operation can introduce alias "ghosts" – signals which don't exist at all.

By BRYAN MAHER

While digital oscilloscopes are powerful instruments, they take some getting used to, particularly for people who have used analog scopes for many years.

In reality, there are significant differences between displays of the same signal seen on a digital or analog oscilloscope. And both displays are likely to be different from the real live signal.

Each scope shows a different image, neither of which is a true representation of the actual electrical waveform. For anyone who has used an analog scope for many years, there must first be the realisation that the screen display is not reality and that both analog and digital scopes give different "filtered" views of real signals.

All of which is an admission that the signal seen on a digital scope can look quite different to the same signal on an analog instrument. Moreover, on a digital scope, it will probably look much noisier. Is that noise really there? Well, yes, in many cases it is and it is just not seen on the analog instrument.

These noisy traces are in sharp contrast to the smooth traces of an analog scope. Together with the complexities of screen menus, they make some long-time analog scope users reluctant to invest in a digital storage scope. This aversion is unfortunate, for it denies those people access to the great signal processing advantages of the digital instrument.

Why the trace wriggles

The wriggly nature of the trace hits you in the eye, even on large amplitude signals, such as that shown in Fig.1. By contrast, the same signal displayed on an analog scope is likely to be as clean as whistle.

What happens when we photographically enlarge a portion of the baseline trace seen in Fig.1? The result of an 8-times magnification is shown in Fig.2. The wriggles are a form of noise. But their large amplitude, even on signals as big as 8V, indicates some source other than random noise at the scope input. And because of the digitising process the digital scope trace tends to have a characteristic "jaggy" appearance.

This is very different from the natural random noise generated in high gain preamplifiers which we see on analog scopes. But some noise impulses are too fast to generate enough light in the phosphor and so are not visible unless we turn up the brightness. This means we are never sure of the true amount of noise when using an analog scope.

The jaggies on all digital scope displays operating in simple mode stem

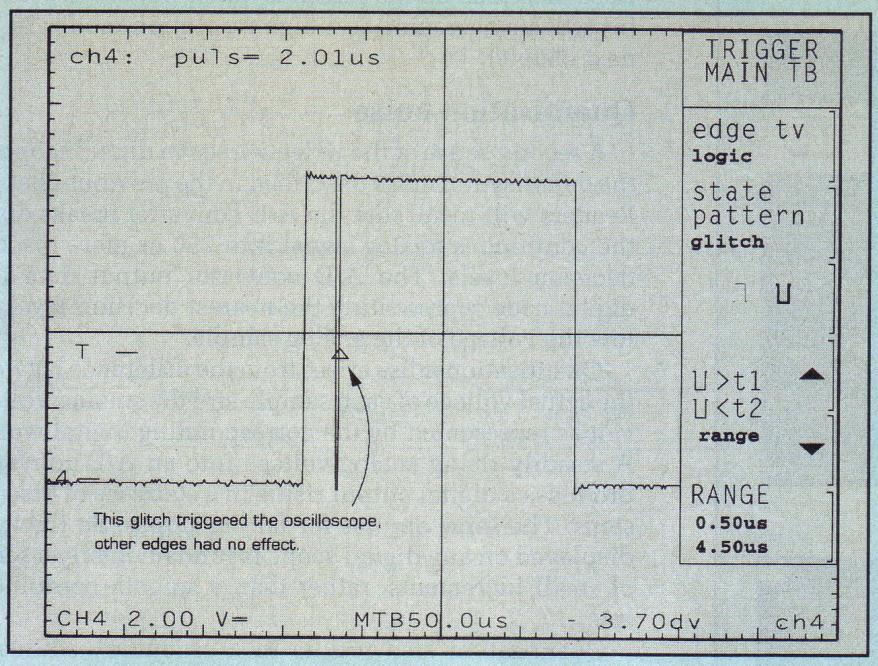


Fig.1: a digital scope can find an elusive glitch but the trace is wriggly, even on 8V signals.

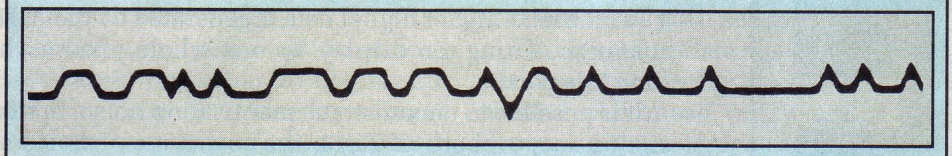


Fig. 2: photographically enlarging the trace of Fig.1 shows an artificial jaggy waveform, characteristic of digital scopes used in simple mode. This jaggy waveform is independent of signal amplitude.

from four sources. The first and predominant cause is inherent noise within the analog to digital (A/D) converters.

Digitising rates

Designers face great problems when digitising rates from 100MS/s up to 8GS/s are required. At this rate, even flash A/D converters are inadequate, because their speed is ultimately limited by the slew rate of the analog comparators used. A new technology is needed.

In many Tektronix digital scopes an extra component is added. At a very fast sampling rate, one complete record (collection) of samples is passed into a proprietary line of special semiconductor analog storage elements.

Then the sampler pauses, while this temporarily stored analog record is shifted out at a slower rate to an A/D converter. The digital data so produced is concurrently recorded in the memory. This double shuffle achieves the complete digitisation at an apparent rate extending up to 5GS/s.

Other manufacturers combine many digitising paths to achieve high speed. The Hewlett Packard HP54720/10 model contains 16 500MS/s 8-bit flash A/D converter channels. All the data outputs can be interleaved to produce an equivalent 8GS/s rate of A/D conversion, with an extremely short effective sampling period of one picosecond.

Such speeds are way beyond the capabilities of any direct single stage A/D converter technology currently in existence. Digitisation in multiple stages, though necessary to achieve the required speed, unfortunately does generate noise. This is the dominant cause of the wriggly baseline and trace observed when any digital storage scope is used in simple mode.

Digital oscilloscope manufacturers admit that the displayed baseline and trace always contains wriggles of two to three pixels in amplitude. One pixel is the smallest possible increment in vertical amplitude of the display and is equal to 1/256 or 0.4% of the screen height.

Because the digitising section comes after the preamplifier and attenuator stages, this noise introduced by A/D conversion is the same at all signal levels. In stark contrast, analog scopes only show baseline noise on tiny signals, of much less than a millivolt.

Averaging mode

One way to reduce the apparent noise on a digital scope waveform is to operate in averaging or High Resolution mode. Averaging means the digital data from a number of successive recurrent sweeps is averaged before being displayed. HighRes is an ingenious method wherein averaging can be done even on a oneshot. Because random noise averages out to zero, the

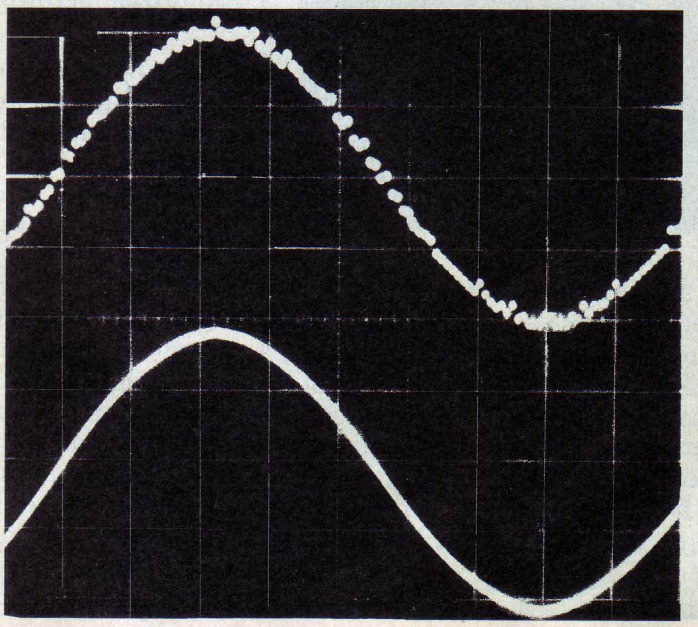
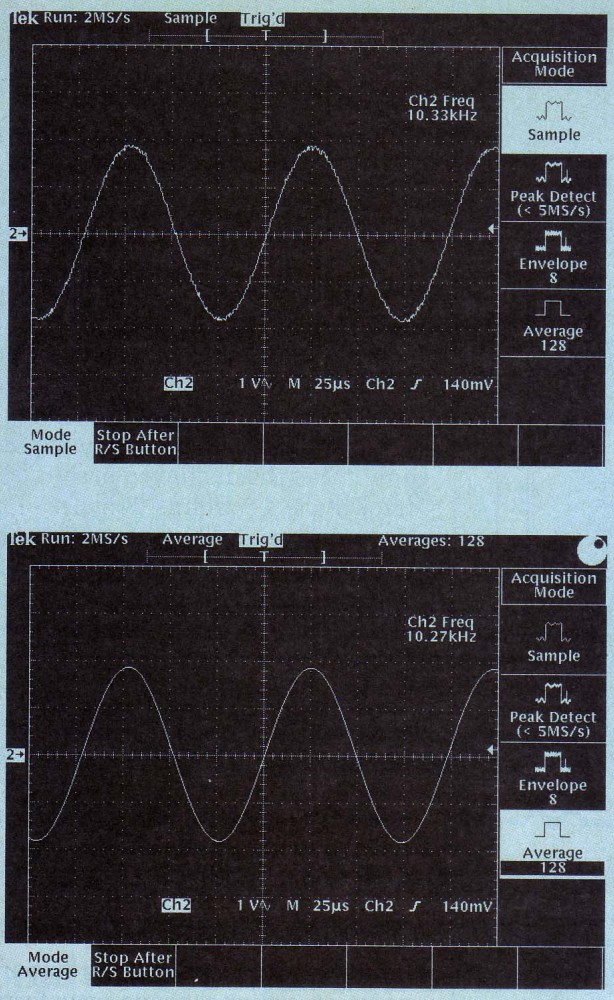


Fig.3: to demonstrate quantisation noise, the lower trace sinewave signal was sampled, digitised and immediately reconverted back to analog, then displayed in the upper trace. Any imperfections not noticed in the lower trace are enlarged in the upper trace by the digitisation.



This sequence of scope waveforms shows a sinewave signal at 10kHz displayed on a digital and an analog scope. The top waveform is from a Tektronix TDS 360 digital scope in sample mode at 2 megasamples/second while the middle waveform is at the same sample rate but in average mode (128 waveforms averaged). Finally, the bottom waveform is from an analog scope. Note the very smooth trace.

trace then seen on the screen is much smoother. We will investigate averaging and high resolution modes in the next chapter.

Quantisation noise

A second cause of the wriggly trace in digital scopes is the quantisation noise described in the previous chapter. Readers will recall that the A/D converter breaks down the continuous analog signal into 256 or more discrete decision levels. The A/D converter output data is a digital code representing the nearest decision level below the voltage of the analog sample.

Quantisation noise arises from the difference between the actual voltage of each sample and the smaller voltage values represented by the corresponding digital words. A steadily rising analog voltage into an A/D converter produces a digital output rising in a staircase of discrete steps. The same applies for falling slopes. So the trace displayed on any digital scope is fundamentally a series of small increments, rather than a smooth continuous line.

Quantisation also results in a secondary source of noise. If an analog signal is just below some particular decision level, any tiny fluctuation or noise spike can push the signal momentarily above that decision level. Thus the next higher digital data is generated by the A/D converter, lifting the display up one whole pixel each time this occurs.

It is possible to demonstrate quantisation noise. In the analog scope photo of Fig.3, the lower trace shows a sinewave which was also fed into a sampler and A/D converter.

The resulting digital data was immediately converted back to analog form by a digital/analog (D/A) converter and the result shown as the upper trace.

Small irregularities are present in the lower sinewave but are too fast or too small to be noticed. And some noise exists in the reference voltage of the A/D converter. Each fast noise impulse momentarily lifts the analog amplitude up into the next decision level, so producing a higher digital word. Thus lots of small step errors are produced.

Pulse stretching

A third effect which makes quantisation noise worse could be called "interference pulse stretching". Many noise pulses are too fast to be seen on an analog scope but when captured by a digital scope's sampler, it holds the signal voltage steady until the next sample is taken. Hence the sampler stretches fast noise pulses out to equal the sampling period, so they can be more clearly seen.

A fourth very important contribution to the wobbly trace displayed on any digital scope is directly related to the waveform capture rate and screen update rate.

This points up the vital difference between the display on any scope and the real live signal we wish to investigate.

Using an analog scope, in many circumstances you will never see noise impulses, for two reasons, as illustrated in Fig.4.

Firstly, they are usually not in synchronism with the scope's horizontal sweep and so occur on a different part

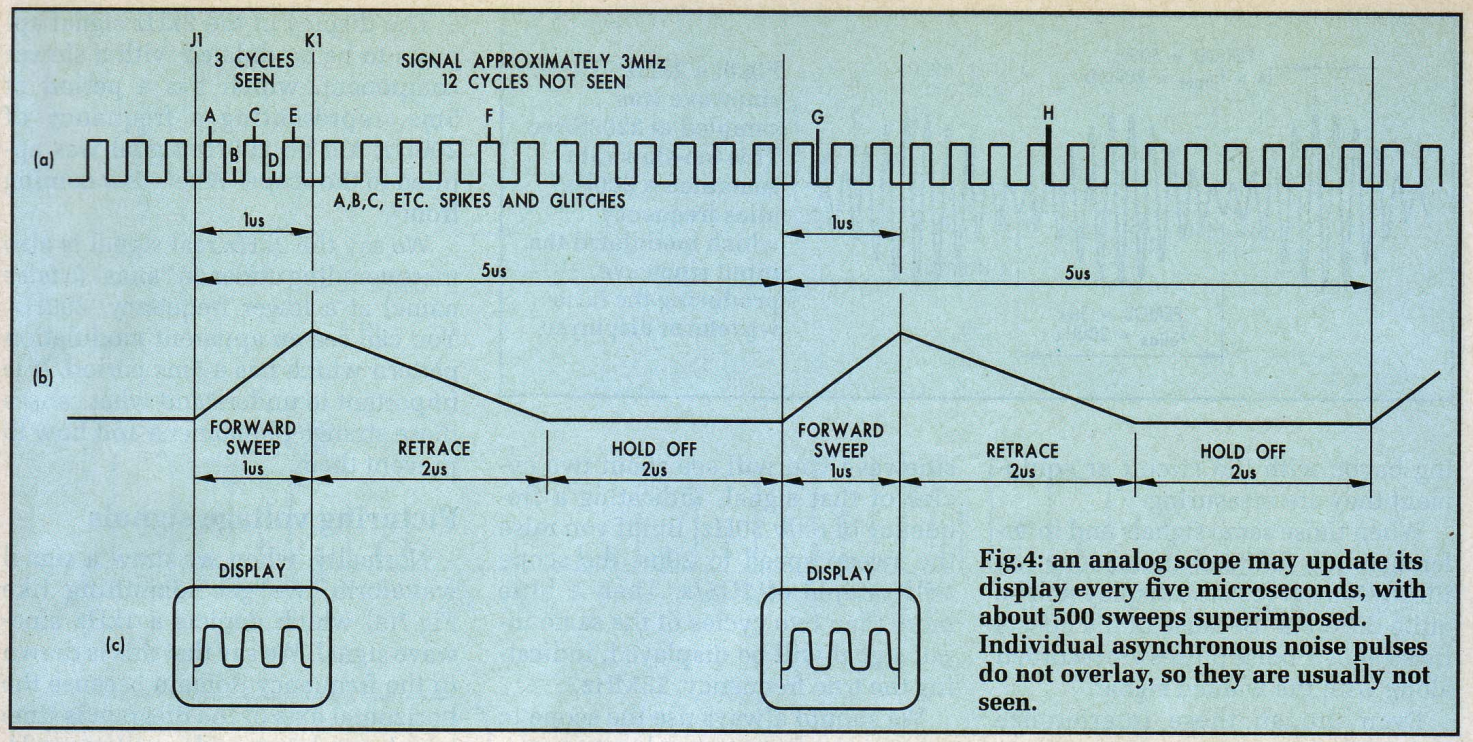


Fig.4: an analog scope may update its display every five microseconds, with about 500 sweeps superimposed. Individual asynchronous noise pulses do not overlay, so they are usually not seen.

of the trace each sweep.

Secondly, and this is of the utmost importance, very often the display on an analog scope is an overlay of hundreds or thousands of superimposed sweeps.

Suppose for example that you are looking at the 3MHz signal shown in Fig.4(a), with the sweep speed set to 0.1µs/div. The forward trace takes 1µs and the retrace and holdoff might occupy 2µs each, as illustrated in Fig.4(b). That is 5µs for each complete display cycle. Therefore, your scope trace will sweep across the screen 200,000 times each second.

This is your update rate, the number of times your display is renewed each second. All these traces are being drawn on your screen, each one on top of the last.

You are capturing and displaying only one out of every five microseconds of the live signal. You could say your waveform capture rate is 200,000 waveforms/second, which in this case is 20% of the live signal.

If you have turned up the brightness (intensity) such that the effective persistence time of the screen phosphor is 2.5 milliseconds, then the display you see is the overlay of about 500 traces superimposed, each showing the same signal pattern.

The display is really the average of 500 views of the input signal, with the noise averaging towards zero. Therefore you will never notice the noise that is present and the trace and baseline will be the smooth clean lines which analog scope users have come to expect.

But this means that analog scope users are blissfully ignorant of noise and interference which could be play-

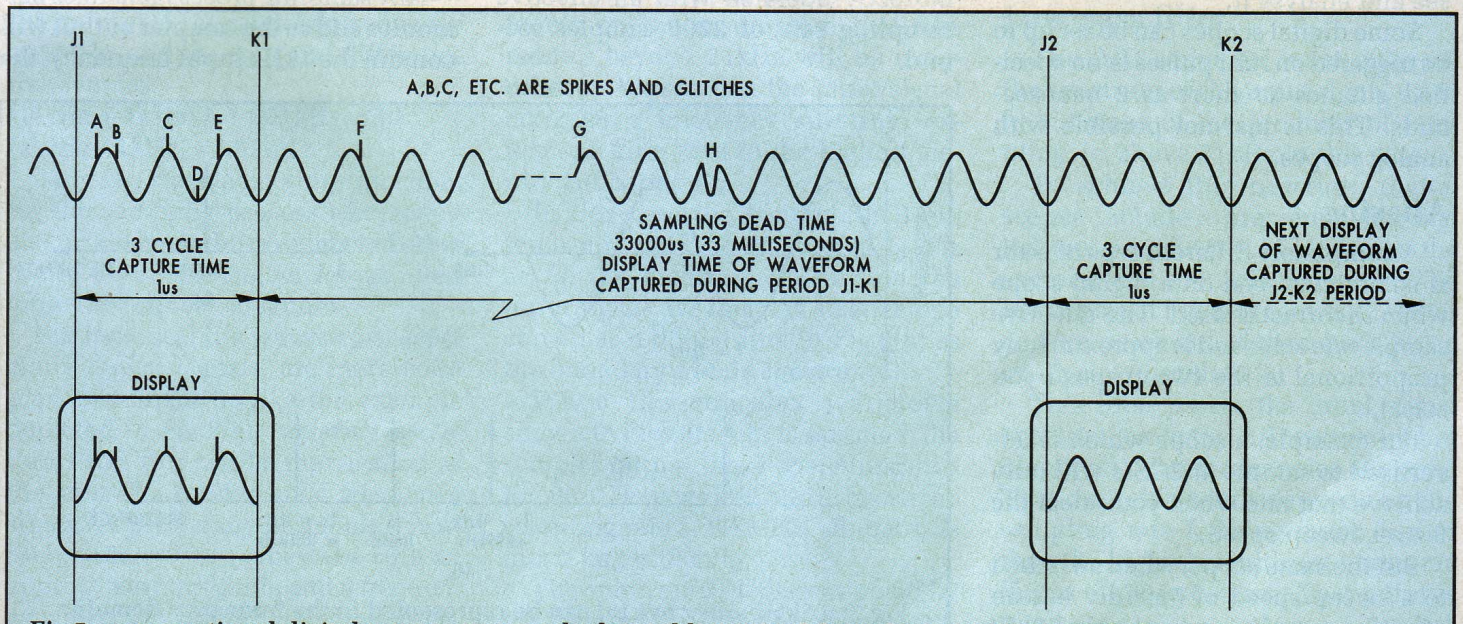


Fig.5: a conventional digital scope may sample the real live signal for only one microsecond, then display that segment for perhaps 33,000us. You see only 0.003% of the live signal.

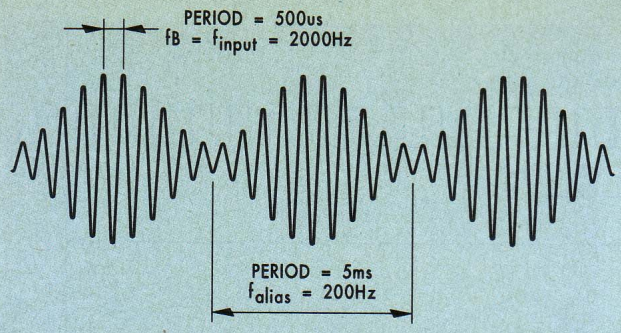


Fig.6: a 2kHz sinewave was sampled at 2200S/sec. This too-slow rate generated a 200Hz alias frequency which modulated the input sinewave, producing the false waveform displayed.

ing havoc with the circuit or equipment they are measuring.

When those same signals and interferences are fed to a digital scope as illustrated in Fig.5, the display will be quite different. Because of the effects listed above, noise pulses are recorded along with the wanted signal.

Even though these interference pulses may be only nanoseconds in duration, they are liable to be displayed. That might be regarded as a disadvantage of the digital scope. But many digital scopes also have a big advantage – they can be programmed to find glitches.

The scope waveform of Fig.1 is such a case. The scope was programmed to search for and trigger the scope display on any pulse which had a duration between 0.5 and 4.5µs.

The instrument found one interference pulse having a duration of 2.01µs within a collection of thousands upon thousands of clean signals. With the scope triggered on this glitch you can see and analyse it.

Some digital scopes can be set up to be triggered on runt pulses or on specified glitches as short as 2 nanoseconds. This is just not possible with analog scopes.

Aliasing

A completely different type of error is sometimes seen on a digital scope when incorrectly used. The effective sample rate achieved is approximately proportional to the sweep speed you select.

For example, a scope which is advertised to sample at 2GS/s will only achieve that rate when you select the fastest sweep speed.

But the same scope, when switched to a sweep speed of 5ms/div has an effective sampling rate of only 10kS/s! That difference is crucial.

At that setting, if you apply a 13MHz sinewave you will see about two cycles of that signal, indicating a frequency of only 50Hz! But if you raise the sweep speed to 20ns, the scope will sample at 2GS/s. Then a little more than two cycles of the same input signal will be displayed, indicating the true frequency, 13MHz.

We should always use the scope to achieve the fastest sample rate possible, otherwise the display may show the wrong frequency reading. Or in other cases we may observe distortion on fast edges in a complex waveform, with the low harmonics reproduced larger and out of proportion to the high harmonics. In other cases a signal may seem to drift across the screen untriggered, like some weird apparition.

Alternatively the screen may display a signal component at a frequency which does not exist at the scope's input terminals, as illustrated in Fig.6.

Here the input signal is a 2kHz sinewave and the digital scope is incorrectly operated with an effective sampling rate of 2200 samples/second.

The display of the 2kHz signal appears to be modulated with a slower component, which has a period of 5ms, representing a frequency of 200Hz. Yet no 200Hz signal was applied to the scope. Where is it coming from?

We say the 2kHz real signal is also masquerading under an "alias" (a false name) at a lower frequency, 200Hz. You can see an apparent modulation pattern which has a 5ms period. It is important to understand what causes these strange phenomena and how to prevent them.

Picturing voltage signals

Normally, when we draw a signal waveform, we get something like Fig.7(a) which depicts a 1kHz sinewave signal. We say that this is drawn in the frequency domain because the horizontal axis of the diagram is time which can be seconds, milliseconds, microseconds or whatever.

But there is another way of depicting the same 1kHz sinewave signal and that is the frequency domain, as shown in Fig.7(b).

In this case, the horizontal axis of the diagram is frequency and since we only have one frequency it is depicted as a vertical line at the 1kHz spot on the axis. The height of the vertical line is measure of the amplitude, just as it is in the time domain.

When you connect a 1kHz signal to a digital scope it will be sampled at some rate, which we will call the effective sampling frequency, f_s.

Any sampling process generates harmonics and so the sampler output will contain the 1kHz input frequency, the

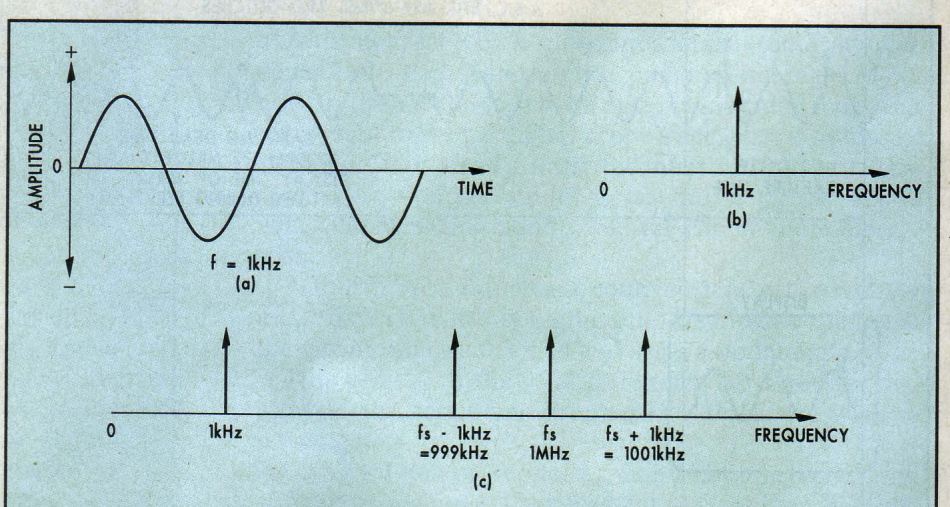


Fig.7: a 1kHz sinewave (a) can be represented in the frequency domain (b) as a vertical line on the horizontal frequency axis. Its height shows its amplitude. Sampling (c) at rate f_s produces extra frequencies at f_s ±1kHz.

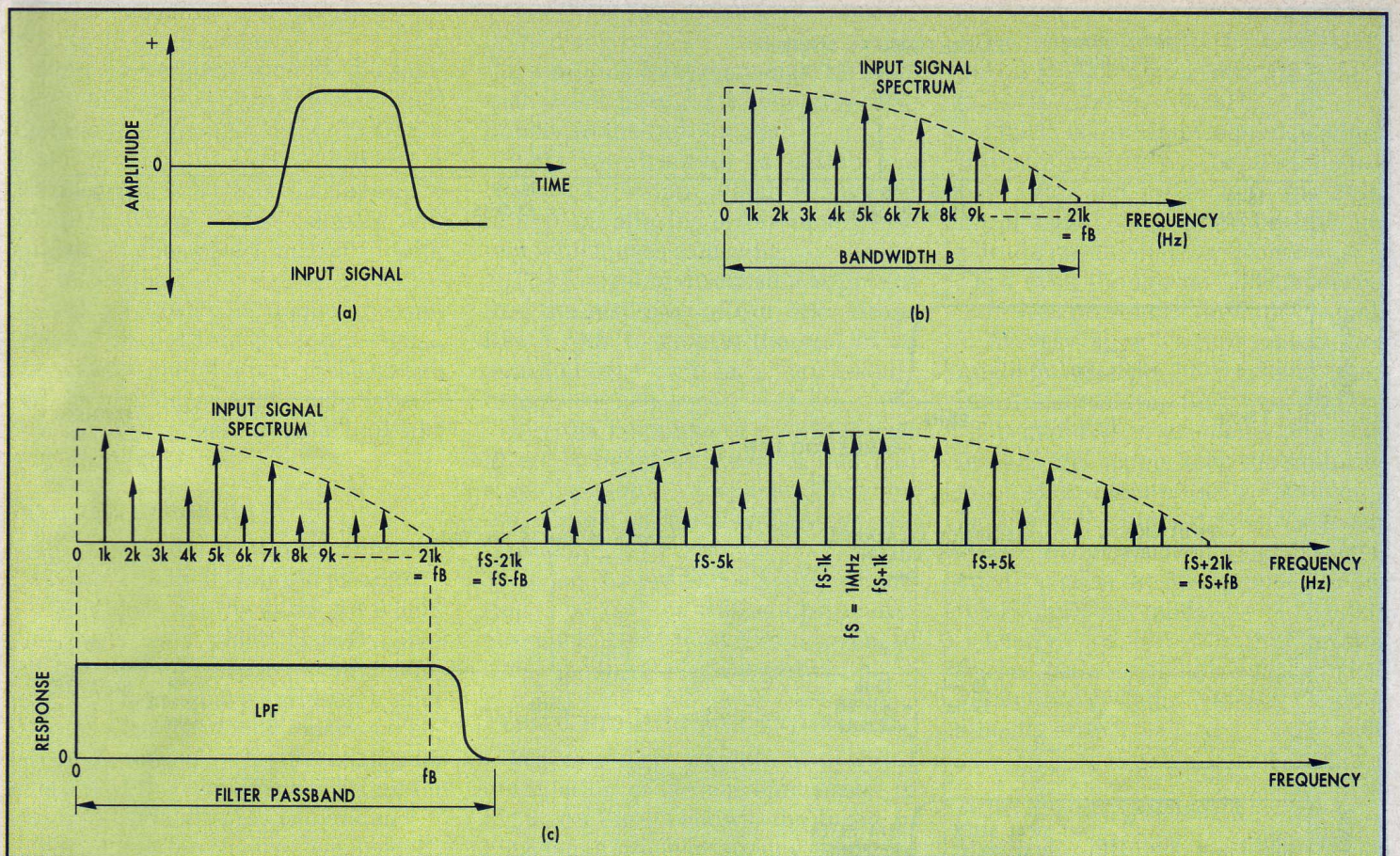


Fig.8: complex waveforms (a) can be depicted in the frequency domain (b) by a sequence of vertical lines representing the fundamental and all significant harmonics. The sampler (c) generates extra copies of all harmonics at the sum and difference of the sample rate f_s and each harmonic frequency.

sampler frequency f_s, plus the sum frequency (f_s + 1kHz) and the difference frequency (f_s - 1kHz). These frequencies are shown graphically in Fig.7(c).

If the sampling frequency is 1MHz, then the diagram of Fig.7(c) will show the input at 1kHz, sampling frequency at 1MHz, and the sum and difference frequencies:

(1MHz + 1kHz) = 1,001kHz; and

(1MHz - 1kHz) = 999kHz

This description is a simplification, for the sampling process also generates an almost infinite number of other multiples at still higher frequencies, which we choose to ignore.

But most real life waveforms, especially digital signals, are more complex and might be like the example depicted in Fig.8(a). Squarish waveforms like this can be represented as the sum of a fundamental frequency sinewave plus many harmonics. And each harmonic is a sinewave with an appropriate amplitude and a frequency which a multiple of the fundamental.

So the waveform shown in the time domain diagram of Fig.8(a) might be described in the frequency domain of Fig.8(b) as a fundamental frequency of 1kHz plus many harmonic multiples at frequencies 2kHz, 3kHz, 5kHz, 7kHz . . . 21kHz, etc.

We have stopped at the 21st harmonic on the assumption that harmonics beyond 21kHz will be insignificant. We say that the input signal occupies a frequency spectrum extending from zero to the highest significant harmonic.

In this case the bandwidth B extends up to 21kHz. We refer to 21kHz as f_B, the highest frequency in the input signal. We imagine an envelope shown as a dotted line in Fig.8(b) as the boundary of this spectrum B.

When the complex waveform shown in Figs.8(a & b) is sampled, the sampler output looks something like Fig.8(c). Here we arbitrarily chose the sampling rate f_s = 1MHz, so that f_s is much larger than f_B.

The sum components generated by the sampler include the frequency f_s added to the fundamental and to each harmonic of the input. These extend from f_s up to the frequency (f_s + f_B). The difference components extended from f_s down to the frequency (f_s - f_B). That is, the spectrum of the sampling products extends from (f_s - f_B) up to (f_s + f_B).

Low pass filter

The A/D converter must only see the spectrum of the input signal up to f_B but none of the products of sampling; ie, above 21kHz in this case.

To achieve this rejection, digital scopes include a programmable digital low pass filter (LPF) between the sampler and the A/D converter. The lower part of Fig.8(c) shows this filter and its passband, drawn here just a smidgen wider than f_B.

This filter passes the input signal spectrum on to the A/D converter but blocks all other frequencies above f_B. That desirable result depends on the sampling rate f_s being much higher than the highest significant harmonic (f_B) in the input signal. That point is vital!

Just how much higher is enough? And what happens if f_s is not high

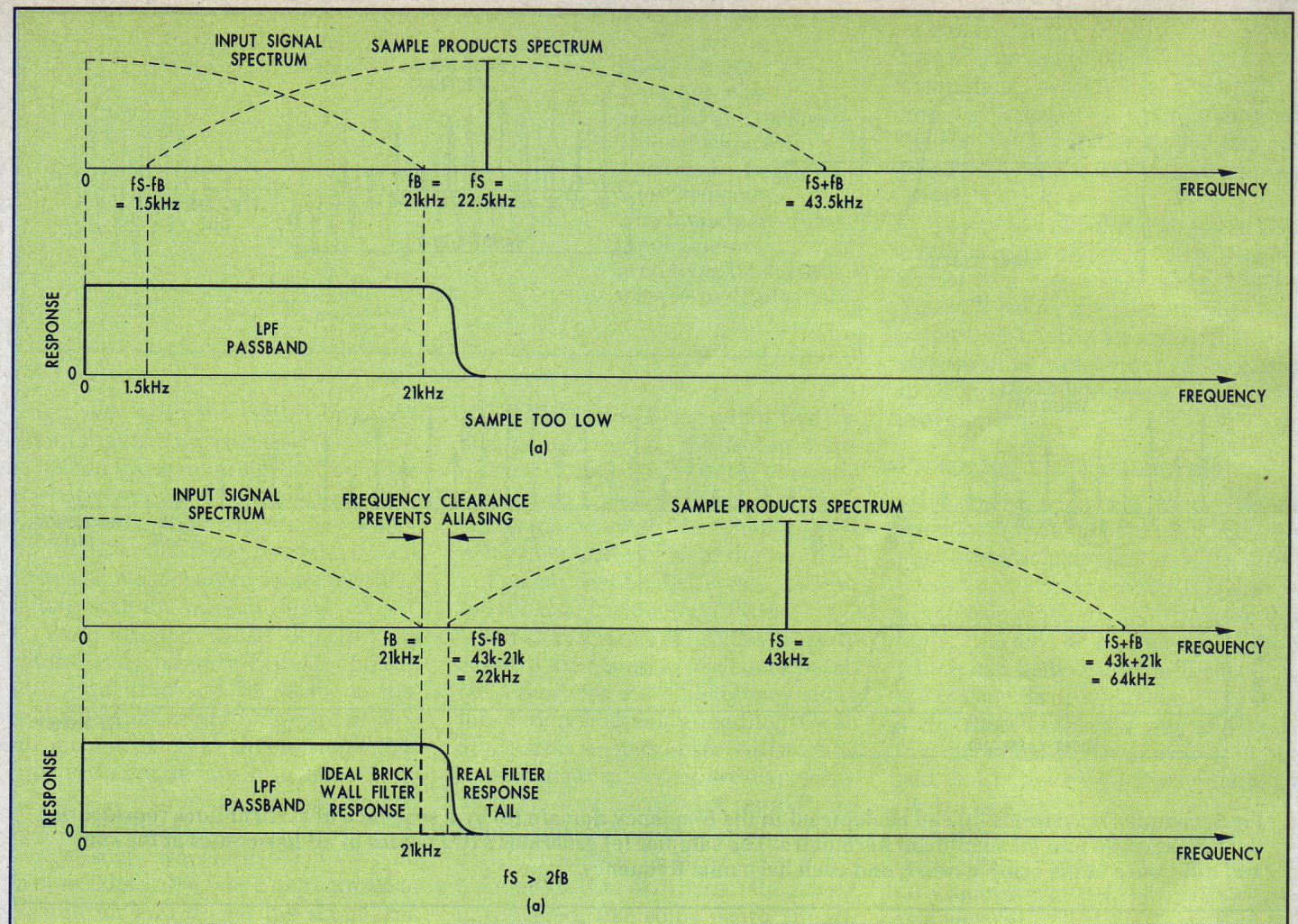


Fig.9: if the sampling rate is too low (a) the spectrum (f_s - f_B) overlaps the filter passband, so alias frequencies are displayed. But (b) if $f_s > 2f_B$, all terms generated by the sampler are rejected by the filter LPF, so preventing aliasing.

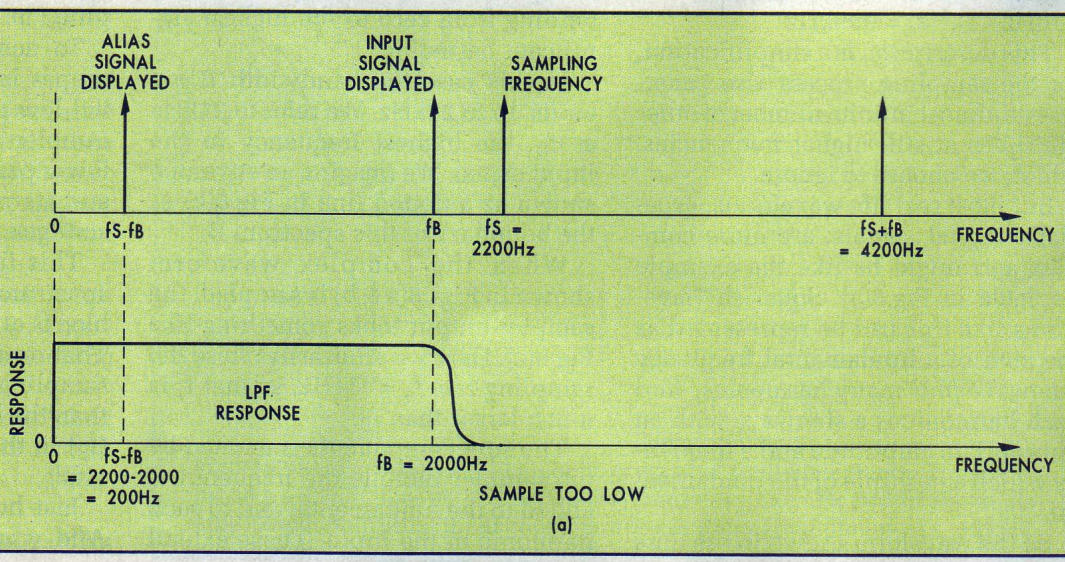
enough? Fig.9(a) illustrates a case where the input signals extend 21kHz but the sampling rate is only 22.5kHz; much too low.

This could occur if you operate the digital scope at too slow a sweep rate. This figure shows just the outline of each spectrum instead of depicting each and every harmonic.

The vital point

Now here is the vital point. Because f_s is so low, the sampler products intrude into the spectrum of the input signal. More importantly, many of those sample frequencies will pass through the low pass filter (LPF). So they pass to the A/D converter and are

Fig.10: this diagram explains the alias frequency component seen mixed with the 2kHz signal in Fig.5. The alias frequency is: (f_s - $f_{(in)}$) = (2.2kHz - 2kHz) = 200Hz.



displayed on the screen!

Frequencies generated by the sampler which overlap the LPF passband include (f_s - f_B) = (22.5kHz - 21kHz) = 1.5kHz; then (22.5kHz - 19kHz) = 3.5kHz; then 5.5kHz, etc in steps up to 20.5kHz. These "false" signals will appear on the screen, mixed in with the real signal.

With all those false frequency components mixed into the input signal, the waveform displayed on the screen will be nothing like the true shape.

Aliasing can make a signal look like something it is not!

Nyquist criterion

So what is the minimum sampling frequency needed to avoid aliasing?

Fig.9(b) shows the situation where aliasing is just avoided. Here the lowest frequency produced by the sampler, (f_s - f_B), is just a smidgen higher than f_B. The frequency clearance between f_B and (f_s - f_B) prevents any overlap of the two spectra. So under this condition aliasing is avoided.

To put that into figures, we need: (f_s - f_B) > f_B; meaning that f_s > (f_B + f_B) or ultimately, f_s > $2f_B$.

In plain English, that means that the sampling frequency must be more than twice the highest frequency component in the input signal.

This requirement is called the Nyquist Criterion, which is invoked to prevent aliasing errors in any system which uses sampling.

The foregoing discussion supposes that the response of the filter drops like a rock to zero at the end of its nominal passband; ie, a "brick-wall" filter.

But the response of real low pass filters is never as steep as that and some harmonic components beyond the nominal passband will always pass through.

Hence, to prevent aliasing distortions, we prefer the sampling frequency to be at least five or even 10 times the input signal bandwidth.

Weird modulation explained

We can now explain the weird modulation of the waveform seen in Fig.6. As Fig.10 shows, the input in Fig.6 was a single frequency sinewave at 2kHz but the sampling rate was too low at 2.2kHz. Sampling generates the extra frequencies: (f_s - f_B) = (2.2kHz - 2kHz) = 200Hz and also: (f_S + f_B) = (2.2kHz + 2kHz) = 4.2kHz.

200Hz is the alias frequency which intrudes into the passband of the low pass filter and mixes with the 2kHz input signal. This produces the amplitude modulated waveform seen in Fig.6 even though no 200Hz component was present in the input signal.

At very slow sweep speeds, you might only see the 200Hz signal, nothing else; a real trap for young players!

To avoid alias problems when using a digital scope, keep the sampling rate high by using either the auto setup facility or the highest possible sweep speed. To determine if a signal seen is an alias, raise the sweep speed or use the Peak Detect mode.

Lastly, we observe that analog scopes, because of their linear vertical deflection systems, cannot produce aliasing errors. **SC**

Acknowledgements

Thanks to Tektronix Australia, Philips Scientific & Industrial and Hewlett Packard for data and illustrations.

Value for Money 60MHz & 100MHz Scopes

Tektronix' new TDS-200 Series scopes are affordable, compact, general purpose digital storage scopes that offer more additional facilities than any analog scope.

The technological breakthrough that these new scopes offer is an extraordinarily high **1GS/s real-time digitising rate** plus a very rapid screen update rate, resulting in a digital scope with display response of an analog scope, at an analog scope price.

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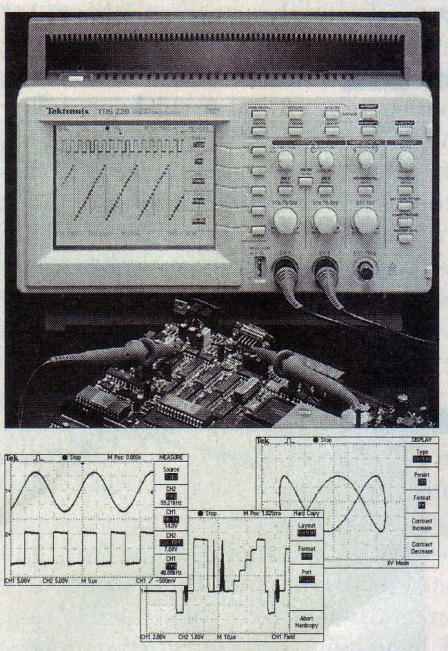
TDS210 $1,395 ex-tax $1,702 incl. Tax



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RADIO CONTROL

BY BOB YOUNG

How radio-controlled models can be lost through interference

This month, we will continue with the comparison between AM and FM and examine some of the ramifications of the two systems. One surprising result is the ease with which a model can be lost through interference.

In the last November 1996 article I mentioned that we received many letters and phone calls about the Mk.22 R/C system and that the most common query was why 29MHz AM? As a result we went into an in-depth analysis of the relative merits of AM and FM and concluded that both systems were incorrectly named and that "FM" was greatly oversold against "AM".

In the end we demonstrated that the difference between the two systems was much less than commonly believed. The 29MHz discussion we left in abeyance and we will have to deal with that another time.

We also dealt briefly with capture effect in FM models which in my mind is a very serious issue, especially when we come to single conversion receivers operating on 36MHz. Let me explain.

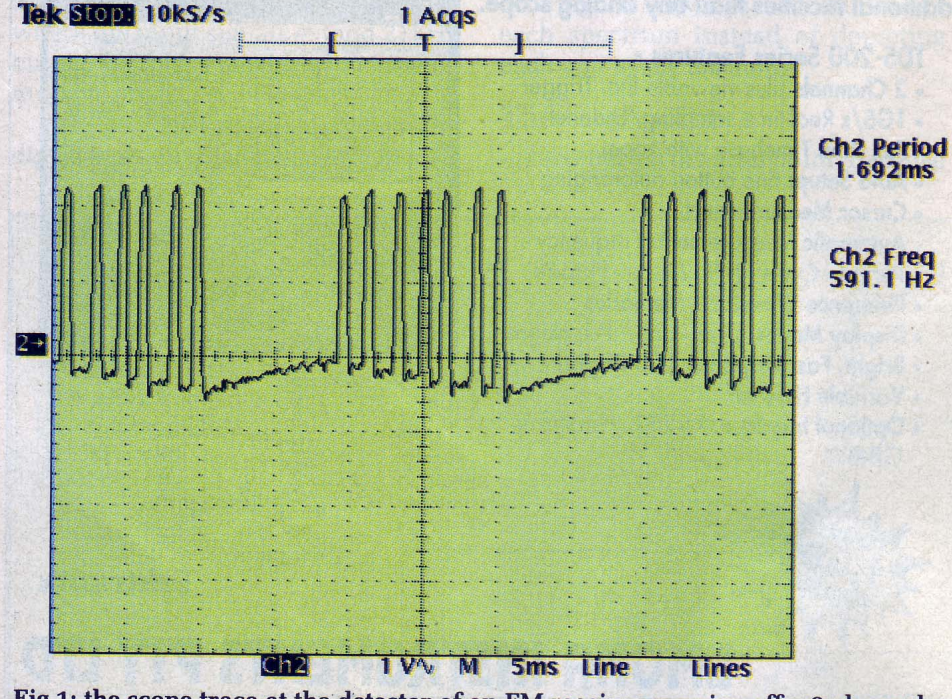


Fig.1: the scope trace at the detector of an FM receiver running off a 6-channel transmitter and with a 7-channel transmitter interfering on the same frequency at a signal level of approximately 1:2.

In our discussion on capture effect in FM receivers we noted that capture is a phenomenon that occurs when an interfering signal on the same frequency exceeds the wanted signal by a small margin. The actual point at which capture occurs depends on the capture ratio of the receiver and may vary from 1dB (1.12:1) to a maximum of 3dB (1.41:1), whereas capture in AM receivers occurs with signal levels of 100:1 or more.

Figs.1, 2 & 3 show the sequence of events leading to capture of a radio control receiver by an interfering transmitter. Fig.1 shows the scope trace at the detector of an FM receiver running off a 6-channel transmitter and with a 7-channel transmitter interfering on the same frequency at a signal level of approximately 1:2. Fig.2 shows the same Rx with the two transmitters at approximately equal level. Note the severe disruption of the signal.

Fig.3 shows that the signal from the 6-channel transmitter has gone bye-bye and it's hello to the 7-channel transmitter signal. Control has now passed over completely to the interfering transmitter, which has exceeded the 1:1 signal level ratio. At this point, the interfering transmitter now has complete control and the model could easily be flown away. Indeed, when FM first made its appearance in England, the press there reported on a spate of incidents where models were flown away by pirate transmitters.

"So what?", I can hear the "experts" saying. Nobody is going to be silly

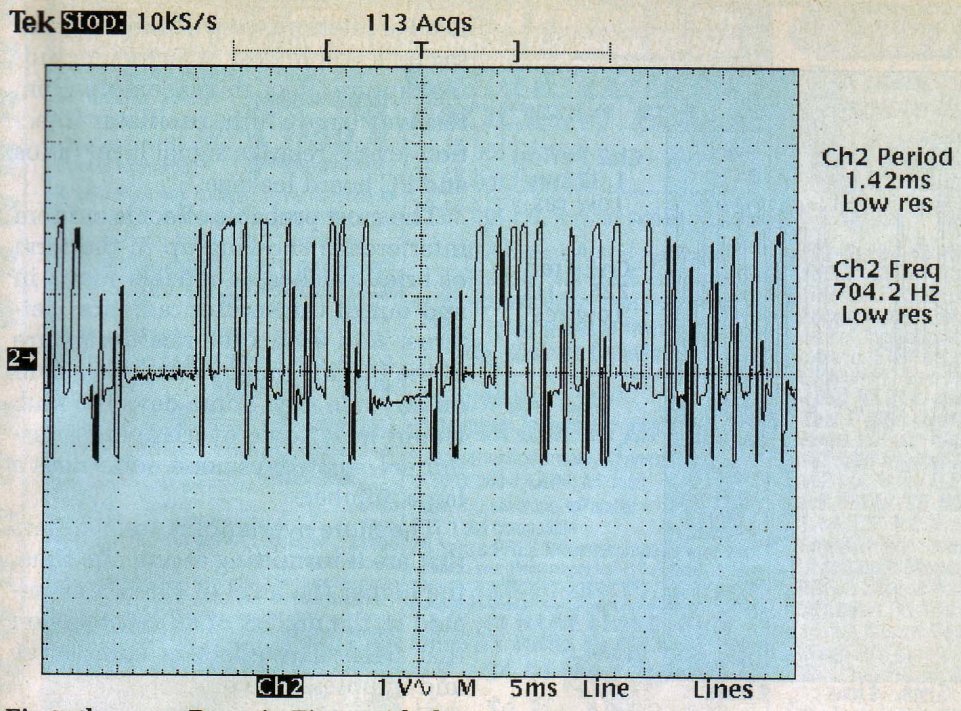


Fig.2: the same Rx as in Fig.1, with the two transmitters at approximately equal level. Note the severe disruption of the signal.

enough to fly two models on the same frequency and in years of flying FM in Australia, there has never been a recorded incident of a model being pirated away.

Well let me tell you there is still a very definite risk of running into strong interference every time you fly on a field using both ends of the 36MHz frequency allocation. There may be no intention of deliberate interference or pirating but you could still lose your model.

When you see how this interference and capture can easily take place you will see that there is still a strong argument for operation on the 29MHz band.

Interference on 36MHz

For some time now, there have been rumblings amongst the technically inclined R/C modellers about the possibility of transmitters spaced 455kHz apart causing interference with each other. The significance of 455kHz is that it is the intermediate frequency (IF) used in all R/C receivers. This has been reinforced by the number of glitches experienced on some flying fields. There have also been rumblings about AM receivers not being satisfactory on 36MHz and this has been put down to interference from harmonics arising from broadcast FM stations.

The problem arises on the 36MHz band due to the fact that it consists of 59 spots spaced 10kHz apart in a 600kHz block. The 27MHz, 29MHz and 40MHz bands are only 300kHz wide or less and therefore there can be no transmitters spaced 455kHz apart in these bands. Hence we are looking at something relatively recent from an R/C point of view. Thus at each end of the 36MHz band there are a number of frequencies which are spaced either 450 or 460kHz apart.

All of this has lead to a deal of confusion on exactly how to handle the situation. It particularly affects me because as the designer and supplier of the Silvertone Keyboard system of frequency control, I am responsible for arranging the keyboards for safe operation on 36MHz.

Up till now I have always recommended that where single conversion receivers are used, they should be on frequencies in the middle of the 36MHz band, while dual-conversion receivers could be used with frequencies at each end of the band. In other words, use dual-conversion receivers on channels 601-614 (36.010MHz to 36.140MHz) and channels 646-659 (36.460MHz to 36.590MHz) and single conversion receivers on channels 615-645.

The rationale behind this is that by using single conversion receivers in a band only 300kHz wide, a 455kHz difference signal would not arise in the mixer and therefore no interference would occur. For the double conversion receivers, the first IF is 10.7MHz and therefore the possibility of the 455kHz difference would not be a problem. That's as I saw it, anyway.

How wrong I was! All of this assumes that the only two channels being affected were the overlapping pair of transmitters.

The situation is complicated somewhat by the fact that 455kHz falls midway between two frequencies. As long as we use only 20kHz keys (2-inch), the key width protects us from this complication.

What has forced me to rethink this problem has been a host of discussion about the existing keyboard and its shortcomings in dealing with the new MAAA 10kHz frequency allocations. When I sat down to write the instructions for the new keyboard I thought that the 455kHz difference was not really a problem. But when I thought about it in detail I realised that maybe I was coming at it from the wrong angle.

I needed to get the facts, so I warmed up the old spectrum analyser, signal generator and CRO and went to it. All of this of course was one day before the magazine deadline (as usual, I can hear Leo muttering). One hour later I finished my refresher course on mixer theory and realised we had all been thinking inside the square. What I rediscovered is this:

Any pair of transmitters separated by 450kHz or 460kHz will generate a very high level of signal in the mixers of single conversion receivers, AM or FM! This will happen in every receiver operating on that flying field, regardless of frequency! In other words one overlapping pair of transmitters will interfere with all 59 receivers operating on the 36MHz band.

Now this is pretty startling stuff and needs some explanation but it is really quite simple. First of all, the receivers operating in the 36MHz band (or any other band for that matter) are wide open to all frequencies in that band. That means that a single conversion receiver which may have a crystal in the centre of the band still receives all the transmitted frequencies across that band – nothing too radical here, so far.

What happens is that normally all of the difference frequencies between

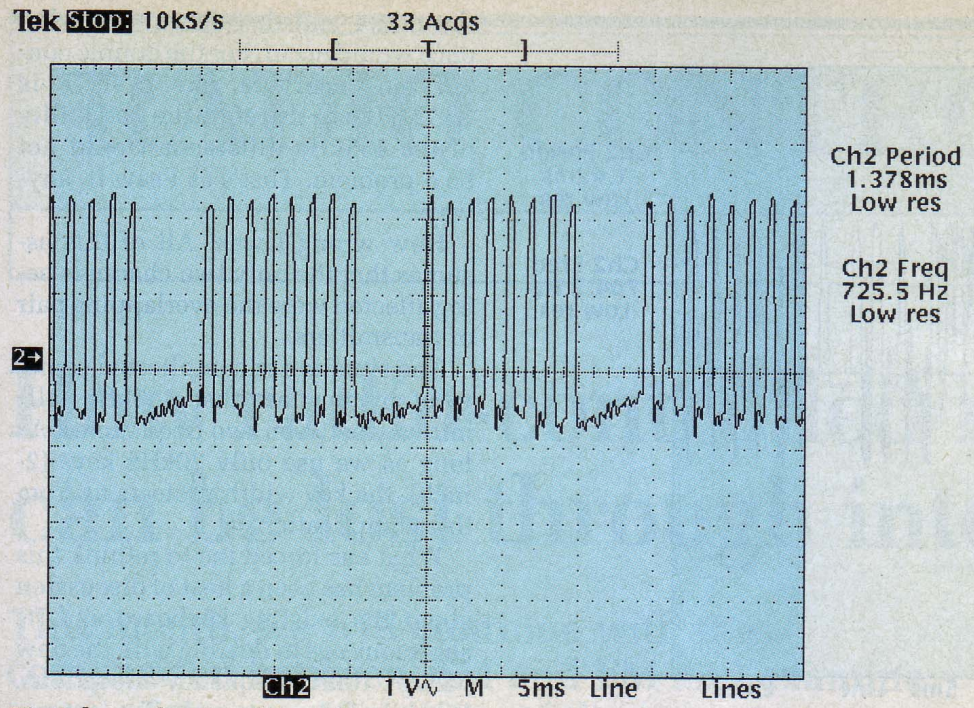


Fig.3: here, the signal from the 6-channel transmitter has gone bye-bye and it's hello to the 7-channel transmitter signal. Control has now passed over completely to the interfering 7-channel transmitter, which has exceeded the 1:1 signal level ratio

the incoming frequencies and the local oscillator (crystal) frequency appear at the output of the mixer. However, the IF amplifier is a very narrow filter which will only pass a 455kHz difference signal to the receiver detector. That is why we change both the transmitter and receiver crystals when we change frequencies, so that the difference between the two is 455kHz.

But if we also have two other transmitter frequencies on the band which differ by 455kHz, they will be picked up by the front end of the receiver, will be fed through to the mixer and the same difference frequency will automatically appear at the output.

So now we have an apparently legitimate signal at the output of the mixer which is very much an interfering signal.

Whether this becomes a problem or not depends on its strength in comparison to the wanted control signal. And this is where capture effect comes into its own.

Capture effect usually works in our favour and tends to lock out the 455kHz interference in all but the worst cases. Thus, it is very difficult to simulate the problem in a simple three transmitter field test. The danger arises mainly in situations where the transmitter radiation patterns suddenly favour the interfering pair.

Now the effects on the flying field of all of this have yet to be verified and extensive testing needs to be put in train immediately. In practice, the level of interference will vary depending on a whole host of factors including capture effect, mixer compression, receiver bandwidth, oscillator injection levels, relative signal level ratios and PC board leakage.

The most probable effect is random interference showing up in the form of brief glitches as models move in and out of transmitter radiation patterns. Add to this the random nature of the pairing on any one flying field on any one day. Some days the club would have some overlapping transmitters, some days none, some days a large number.

The more overlapping transmitters that are transmitting at any one time, the higher the level of 455kHz generated in the mixers of all receivers on that field. The effect is cumulative and impossible to predict.

Now you can see why capture is so important. Nobody would be silly enough to fly on the same frequency but we are accidentally generating the same frequency every day on flying fields all over Australia, wherever overlapping pairs of transmitters are allowed to operate.

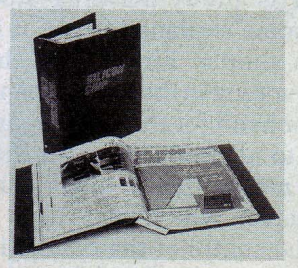
The testing I have carried out to date is brief and incomplete. I simulated the 3-transmitter scenario by removing the crystal from a single conversion receiver. I could then work the servos from my modulated signal generator using a second unmodulated transmitter 455kHz away to supply the mixing signal.

In this mode, I could achieve the equivalent of normal receiver sensitivity, depending on the relative strengths of the incoming signals.

With a crystal in the receiver (any frequency) and no carrier from the wanted transmitter, this effect was still present but diminished somewhat, probably due to mixer compression. I did not test with a carrier because capture would confuse the issue and it is here that extensive testing needs to be done.

To reiterate, wherever single conversion receivers are in use, transmitters overlapping by 450kHz or 460kHz must not be used.

The foregoing is yet another reason for me to continue to push for 29MHz AM. It is simple, cheap and reliable. It is free of the complications and expense of 36MHz FM and is by far the most cost-effective system for sports fliers. **SC**



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$569 tax inc

NO PICTURE AVALABLE AT TIME OF PUBLICATION

PRINTER 2 PORT PnP CARD 16-BIT

Single parallel 16-bit printer port card with two parallel ports. LPT 1 to LPT 3 under MSDOS and LPT 1 to LPT 14 under Windows 95 operating environment.

BONUS SOFTWARE

These great EPSON printers now comes with bonus software to help you create and print colourful greeting cards, flyers, signs, business presentations, etc. Software include:
•Sierra Print Artist for Windows V3.0 •Adobe PhotoDeluxe for Windows V1.0 •Adobe PhotoDeluxe for Macintosh V1.0 and Some "Fun" fonts and "Fab" photos. Also for a limited time PhotoPlus for Windows will be included.

EPSON STYLUS™ 500

C92314 $579

See page 9 for full details for these printers

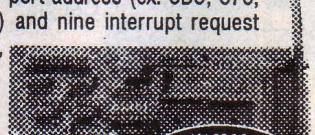
EPSON STYLUS™ 200

$399

PHOTO QUALITY COLOUR

PRINTER LPT123 PnP CARD 16-BIT

This is an ISA bus 16-bit parallel card. Designed with Windows Plug and Play in mind, it includes fourteen Parallel port address (ex. 3BC, 378, 278, 208, etc...) and nine interrupt request signals (IRQ 3, 4,



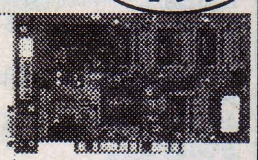
FEATURE:
- Support one or two Parallel port.
- Selectable Parallel port from IRQ 3, 4, 5, 7, 9, 10, 11, 12, 15.
- All functions can be disabled or enabled.

STEALTH 3D

FOR OUTRAGEOUSLY FAST GRAPHIC!

NEW DIAMOND STE ALTH 3D VIRGE VIDEO CARD

XI8216 $199



This new addition to the Stealth family will speed up the graphics, video and overall performance of your PC. Stealth 3D is packed with features and outperform similar class of video cards available in the market. It uses the latest in video display technology -the S3 VIRGE Chipset. •3D hardware acceleration •2MB EDO DRAM upgradeable to 4MB •PCI 2.1 compliant •OEM Pack with software driver disk only. *Logon to rie.net.au for full WinBench® 96 comparision and monitor frequencies info.*

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FTP & NEWS access

LATEST CPU PRICE

intel

PENTIUM 100MHz	$199
PENTIUM 120MHz	$149
PENTIUM 133MHz	$349
PENTIUM 150MHz	$509
PENTIUM 166MHz	$699

LOOK! LATEST PENTIUM PRO CPUs & MOTHERBOARDS

CPU	CPU ONLY	M.B. INCL.
150MHz	NA	$999
180MHz	$899	$1599
200MHz	$1099	$1799

AVAILABLE ON ORDER AT OUR STORES OR BY MAIL ORDER

COMPUTER CARDS - HUGE RANGE!!

CAT NO.	DESCRIPTIONS	PRICE
	ISA	
X18075	1Meg 16bit VGA	$159
X18004	IDE/SPG	$39
X18005	High Speed I/O	$59.95
X17072	ADAPTEC SCSI 16bit 1522A	$189
X18165	16bit ETHERNET RJ45 + BNC	$49
X18169	16bit NE2000+	$119
X15810	Ethernet 5-port 10 base T hub	$169
X15814	Ethernet HUB 10 base T Connector (8 RJ45 Effective)	$199
X15816	Ethernet HUB 16 base T Connector (14 RJ45 Effective)	$349
X15818	Ethernet HUB 20 base T Connector (19 RJ45 Effective)	$369
X18228	Printer Lpt123 PnP Card 16-Bit	$49
X18232	Printer 2-Port Slot Lpt123 PnP Card 16-Bit	$69
X18190	Printer Slot Lpt 1-2 Card	$39
X18191	Printer Port Slot Lpt 1-2-3 Card	$49
X18141	High Speed Serial Card 1-Port 16550	$49.95
X18041	High Speed Serial Card 2-Port 16550AFN	$69
X18143	High Speed Serial Card 4-Port 16550AFN	$189
NEW!	Dual Speed 16650 UARTS modem chip	$99
X18019	Games Card	$19
C14260	SMART GAMES Cont	$39.95
X18514	FULL -DUPLEX ISA **ETHERNET**	$99
X18171	Ethernet **Intel PnP** BNC/RJ45 16-bit	$199
	*Ethernet **III Rev B Coax (BNC, AUI)**	$250
X17396	OEM SBlaster PnP Vibra 16 with IDE interface	$109
X17394	OEM SBlaster PnP Vibra 16 without IDE interface	$99
X17398	OEM SBlaster PnP Vibra 32 Sound Card	$189
X17357	OEM PhoneBlaster	$289
X17250	ESS 16 Bit Sound Card	$55
	SB OEM products do not have manual or connection cables	
	***AVAILABLE TO ORDER**	
	VLB	
X18003	ENHANCED VESA MULTI I/O	$49
X18050	VESA IDE ENHANCED MULTI I/O- **PROMISE TECH**	$129
X18195	VESA VGA CARD	$149
	PCI	
X17900	PCI 1M VGA TRIDENT 9440	$79
X18206	PCI VGA DIAMOND STEALTH 1MEG DRAM	$109
X18207	PCI VGA DIAMOND STEALTH 2MEG DRAM	$139
X18208	PCI VGA DIAMOND STEALTH 2MEG VRAM	$399
X18209	PCI VGA DIAMOND STEALTH 4MEG VRAM	$799
X18218	New OEM PCI Diamond Stealth 3D Video 2MEG	$199
X18230	New MYSTIQUE 2MEG 3D ACCELERATOR	$360
X18183	PCI VGA CIRRUS LOGIC 5430 1MEG	$75
X18195	PCI VGA 64-BIT CIRRUS LOGIC 5436	$199
X18210	2MB WRAM GrafixStar 700 Video	$499
X17073	PCI SCSI MASTER ADAPTEC 2940	$399
X17077	New **PCI ULTRA WIDE SCSI ADAPTEC 2943**	$569
X18212	PCI MGA MILLENNIUM 2MB WRAM	$395
X18214	PCI MGA MILLENNIUM 4MB WRAM	$595
X18216	PCI MGA MILLENNIUM 8MB WRAM	$995
X18150	PCI Ethernet BNC/RJ45	$79
	*Etherlink III PCI Twsited Pair (RJ45)	$185
	*Etherlink III Combo Pack (BNC, AUI)	$280
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Comes with 4 Screws. Black in colour.

	1-9	10+
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H10126 130 x 68 x 41mm	$2.50	$1.95
H10122 150 x 90 x 50mm	$3.95	$3.50
H10124 195 x 113 x 60mm	$4.95	$ 4.25

WITH METAL TOP

	1-9	10+
H10101 150x 90 x 50mm	$4.95	$4.75
H10102 195 x 113 x 60mm	$5.95	$5.75
H10103 130 x 68 x 41mm	$2.75	$2.50
H10105 83 x 54 x 28mm	$2.50	$2.40

GREY FLAT RIBBON CABLE

Cat no.	$/Mtr 1-9	10-99	100+
W12614 -14way	$1.50	$1.20	$1.00
W12616 -16way	$1.75	$1.50	$1.20
W12620 -20way	$1.95	$1.75	$1.40
W12624 -24way	$2.25	$1.95	$1.50
W12625 -25way	$2.25	$1.95	$1.50
W12626 -26way	$2.50	$2.10	$1.90
W12634 -34way	$2.95	$2.50	$2.10
W12636 -36way	$3.10	$2.70	$2.20
W12640 -40way	$3.50	$2.90	$2.40
W12650 -50way	$3.95	$3.50	$2.75
W12660 -60way	$4.50	$3.90	$3.00

ON SUPA SPECIAL

GENERAL PURPOSE TRANSISTORS

PN100: a NPN general purpose medium power amp and switch with continuous collector current up to 500mA. PN200: a PNP general purpose amp at collector currents to 1 AMP. Both are TO-82 plastic package.

PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3414, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210.

PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N205A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447.

PN100.....T90001
PN200.....T90002

1-9	10+	100+
$0.20	$0.18	$0.15

DIODES BUY IN BULK & SAVE!

Cat No.	10+	100+	1000+	10K
Z10135 IN4148	$0.05	$0.04	$0.03	$0.02
Z10105 IN4002	$0.06	$0.05	$0.04	$0.03
Z10107 IN4004	$0.08	$0.06	$0.05	$0.04
Z10110 IN4007	$0.10	$0.07	$0.06	$0.05
Z10115 IN5404	$0.18	$0.14	$0.13	$0.11
Z10119 IN5408	$0.20	$0.16	$0.15	$0.14

NICADS

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

	1-9	10+	100+
Size AA 600mmAH	$2.95	$2.75	$2.50
Size C 1.2 A H	$9.95	$9.50	$8.95
Size D 1.2 A H	$6.95	$5.95	$5.50

LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct import" low profile IC sockets! PCB mounting solder tall. All tin plated phosphor bronze or berrylllum and dual wipe for reliability.

	1-9	10+	100+
P10550 8pin	15¢	12¢	8¢
P10560 14pin	20¢	18¢	12¢
P10565 16pin	20¢	18¢	13¢
P10567 18pin	30¢	25¢	16¢
P10568 20pin	35¢	30¢	22¢
P10569 22pin	35¢	30¢	23¢
P10570 24pin	35¢	30¢	24¢
P10572 28pin	45¢	35¢	25¢
P10575 40pin	50¢	37¢	27¢

WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze.

P10579 8pin	$1.50	$1.40
P10580 14pin	$1.85	$1.70
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P10590 20pin	$2.95	$2.75
P10592 22pin	$2.95	$2.70
P10594 24pin	$3.95	$3.50
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25% more from RIE at the same prices as our opposition

H10810	250gm	$4.95
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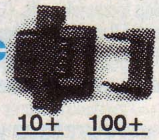
IDC PLUGS AND SOCKETS FROM ONLY $2.20

D TYPE IDC PLUGS

	1-9	10+	100+
DE9P 9pin plug P12166	$1.95	$1.75	$1.50
DA15P 15pin plug P12168	$1.95	$1.75	$1.50
DB25P 25pin plug P12170	$3.95	$2.95	$2.50



D TYPE IDC SOCKETS

	1-9	10+	100+
DE9P 9pin socket P12167	$1.95	$1.75	$1.50
DA15P 15pin socket P12169	$1.95	$1.75	$1.50
DB25P 25pin socket P12171	$3.95	$2.95	$2.50

ECONOMY TRANSFORMERS

Description	1-9	10+
2155 240V 6-15V 1A M12155	$9.95	$8.95
2156 240V 6-15V A2 M12156	$13.95	$12.95
2851 240V 12-6V CT 250mA M12851	$7.95	$6.95
6672 240V 15 30vc 1A tapped M16672	$14.95	$12.95

TOGGLE SWITCHES

	1-9	10+
S11010 *S.P.D.T*	$1.20	$1.10
S11020 *D.P.D.T*	$1.30	$1.20

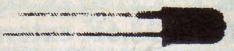
ICB VOLTAGE REGULATORS

Description	1-9	10+	100+
7805UC	$1.00	$0.90	$0.75
7812UC	$1.00	$0.90	$0.75
7815UC	$1.00	$0.90	$0.75
7905UC	$1.00	$0.90	$0.75
7912UC	$1.00	$0.90	$0.75
7915UC	$1.00	$0.90	$0.75
78L05	$0.40	$0.30	$0.28
78L12	$0.40	$0.30	$0.28
LM324	$1.00	$0.90	$0.80
555	$0.60	$0.55	$0.50
741	$0.75	$0.65	$0.60

PC BOARD HOLDER

A must for all PCB work.

T12444 $9.95



QUALITY 3mm LEDS

	1-9	10-99	100+	1000+
Z10140(R)	*$0.15*	$0.12	*$0.10*	$0.08
Z10141(G)	*$0.20*	$0.18	*$0.15*	$0.12
Z10143(Y)	*$0.20*	$0.18	*$0.15*	$0.12
Z10145(O)	*$0.20*	$0.18	*$0.15*	$0.12

QUALITY 5mm LEDS

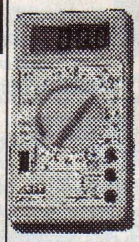
Z10150(R)	*$0.15*	$0.12	*$0.10*	$0.08
Z10151(G)	*$0.25*	$0.20	*$0.18*	$0.12
Z10152(Y)	*$0.25*	$0.20	*$0.18*	$0.12

INCREDIBLE VALUE FOR MONEY

MULTIMETER SPECIAL

DIGITAL MULTIMETER

The ideal meter for technicians with a full 3½ digit LCD readout. Requires a 9V battery either alkaline or carbon. Expected life of carbon battery is 100 hours and 200 for the alkaline.



Q13077

1000'S SOLD

SPECIFICATIONS:
DC Voltage: 200mV/2/20/200/1000V
Basic accuracy: +/-0.5%
Input Impedance: 1M
Maximum Input: 1000V DC
AC Voltage: 200/750V
DC current: 200A/2000A/20mA/200mA/10A
Resistance: 200Ω/2000Ω/20kΩ/200kΩ/2M
LCD Display: 15 x 46mm
Dimension: 70 x 126 x 24mm

1-9 $17.95 10+ $15.95

16550 UART

Features of the UART include programmable data, format parity, framing and overrun error detection etc.

	1-9	10+
U22187	*$14.95*	*$12.95*

TRANSISTORS BUY IN BULK & SAVE!

	1-9	10+	100+
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BC 548	$0.15	$0.10	$0.07
BC 549	$0.15	$0.10	$0.07
BC 557	$0.15	$0.10	$0.07
BC 558	$0.15	$0.10	$0.07
BC 559	$0.15	$0.10	$0.07
BC 327	$0.20	$0.15	$0.12
BC 337	$0.20	$0.15	$0.12
BD 139	$0.70	$0.60	$0.50
BD 140	$0.70	$0.60	$0.50

CANNON TYPE CONNECTORS

Cat No.	Product	1-9	10-99	100+
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P10962	3 Pin Chassis Male	$2.50	$2.00	$1.50
P10964	3 Pin Line Female Socket	$3.50	$3.00	$2.75
P10966	3 Pin Chassis Female	$3.50	$3.00	$2.50

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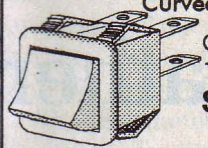
SWITCHES

ON-OFF SWITCH
IN STOCK FOR COMPUTER CASE
Curved Rocker Switch

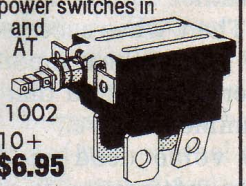


Cat No. S11005
1-9 10+
$6.95 $5.95

- Attractive snap in panel mounting DPST Rocker switch. Connection is by 6mm blade terminals, suitable for crimp connectors.
- Panel cutout 25 x 25mm
- Max panel thickness 3mm
- Switch rating 10A@250VAC.

POWER SWITCH
Push on- Push off power switch assembly

- Screw mounted (Ø 3) switch assembly DPST
- Connection is by 6mm Black terminals suitable for crimp connectors
- Mounting centres 20mm
- Switch rating 5A@250VAC
- Suitable for power switches in minitowers and new baby AT casing,



Cat No. S11002
1-9 10+
$7.95 $6.95

ROUND/SQUARE SWITCHES

	Colour	1-9	10+
PCB MOUNT SQUARE TOP-			
S11196	Black	$1.20	$1.00
S11197	Yellow	$1.20	$1.00
S11198	Green	$1.20	$1.00
S11199	White	$1.20	$1.00
S11200	Blue	$1.20	$1.00
PCB MOUNT ROUND TOP-			
S11095	Red	$1.00	$0.80
S11096	Black	$1.00	$0.80
S11097	Yellow	$1.00	$0.80
S11098	Green	$1.00	$0.80
S11099	White	$1.00	$0.80
PUSH ON/OFF ROUND TOP-			
S11092	Red Top	$1.95	$1.85

BUY IN BULK AND SAVE!!
Toggle Switches

	NORM	1-9	10+
SWITCH ECON MIN/TOGGLE C/OFF SPDT			
S11025	$2.50	$1.00	$0.80
SWITCH R.A PCB TOGGLE SPDT			
S11040	$2.50	$1.95	$1.50
SWITCH R.A PCB TOGGLE DPDT			
S11042	$2.95	$1.95	$1.50

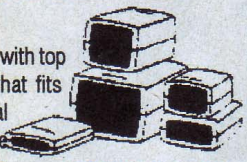
BOXES

AUSTRALIAN MADE DIECAST BOXES

BULK BUY PRICE!

	NORM	1-9	10+
DIECAST BOX 100x50x25MM C1			
H11451 ..	$6.95	$4.95	$4.75
DIECAST BOX 120x65x40MM C3			
H11453 ..	$10.95	$8.95	$7.75
DIECAST BOX 190X120X60MM C5			
H11462 ..	$24.95	$15.95	$13.75

ABS MOULDED BOXE

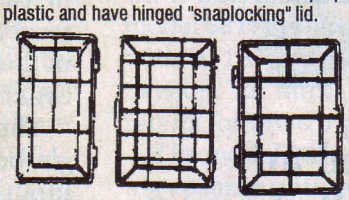


Plastic boxes with top and bottom that fits together. Ideal size for remote control items. With end face plate

BULK BUY PRICE 1-9 10+

90 x 50 x 16 MM		
H30300	$2.95	$2.50
90 x 50 x 24MM		
H30305	$2.95	$2.50

HANDY COMPONENTS HOLDERS
Use these handy compartmentated boxes to store all your bits and pieces of electronic components, parts and other stuffs for easy access. Each one is made of robust opaque plastic and have hinged "snaplocking" lid.



FIVE COMPARTMENT PART BOX
One large and four small individual sections. 172W x 90D x 38H mm
H10088 ..... **$5.95**

SEVEN COMPARTMENT PART BOX
One large and six small individual sections. 180W x 118D x 42H mm
H10089 ..... **$6.95**

SEVENTEEN COMPARTMENT PART BOX
One large and sixteen small individual sections. 270W x 173D x 40H mm
H10090 ..... **$9.95**

PLASTIC BOXES WITH PLASTIC LIDS
(Comes with 4 screws)

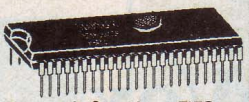
BLACK IN COLOUR

H10188 PLASTIC UTILITY BOX 83 x 54 x 28mm **$10.95**
H10114 PLASTIC UTILITY BOX 125 x 80 x 31mm **$10.95**
H30150 PLASTIC UTILITY BOX 222 x 146 x 55mm **$22.95**
H10086 MULTI PURPOSE MEDIUM BOX **$10.95**
H10087 MULTI PURPOSE SMALL BOX **$9.95**
H10474 ARLEC INSTRUMENT CASE 140 x 130 x 70mm **$16.95**

COMPONENTS

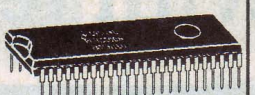
HIGH SPEED UARTS

16550



High operating speed 16 byte transmit & recieve FIFO buffers
Cat No. U22187 1-9 **$15.95** 10+ **$13.95**

16C650



High operating speed with 32 byte transmit & receive FIFO buffers, programmable Xon-Xoff characters and sleep mode
Cat No. U22188 1-9 **$23.95** 10+ **$21.95**

SUPER CAPACITOR

FARAD 5.5V
R15620
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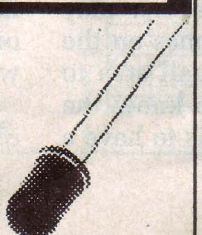

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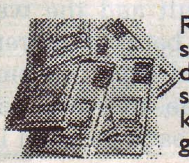

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PRODUCT SHOWCASE

WeatherVox – an automatic weather station with telephone access

Sphere Communications has launched an innovative weather station system called WeatherVox. It has all the main features of a normal weather station except that you can phone it from anywhere and get a voice report of the weather over the last 24 hours.

Most of us rely on the Australian Bureau of Meteorology for the nightly weather report but for many individuals and organisations, the Bureau's reports are insufficient or not localised enough.

For example, a rural fire brigade may be responsible for a large region of rugged mountainous country which is heavily forested. Access may be vary difficult and the weather may easily vary between extremes on the one day and from one small area to another. The only way to know the weather in each location is to have a weather station in each area. That may be well and good but how do you access the weather information which is being recorded?

This was the question that exercised the minds of the people at Sphere Communications. They could see many applications for this device, among rural fire brigades, boating organisations, golf clubs, life savers, fishermen, farmers, foresters or anyone with a need for specialised weather information.

Even people with holiday homes or boats on remote moorings could have an application for this device.

What Sphere Communications did was to design a computer to interface to an Ultimeter 2000 commercial weather station made by Peet Bros Company, Inc, a company based in New Jersey, USA. The computer interface reads all the weather data from the weather station and stores it in RAM. Then, when accessed by phone, it will give a voice report on all the weather information that it has been programmed to give.

The voice used to deliver the weather information is that of well-known Sydney radio & TV announcer Grant Goldman. His voice, or rather, many words and phrases, are stored in two ISD 2590P 90-second voice recorder ICs (this device was featured in the February 1994 issue of SILICON CHIP).

The WeatherVox is a actually a single board computer with an RS-232 input for the weather station connection and a telephone interface, using American RJ-11 and RJ-12 telephone sockets, respectively. A number of functions within the WeatherVox can be addressed or changed by pushing buttons of a standard DTMF tone phone.

Three levels of voice report are available on the WeatherVox: Brief, Intermediate and Detailed. The Brief report includes time of day, current outdoor temperature, overnight low temperature and time at which it occurred, wind speed and direction, peak gust today and time of occurrence, average wind speed over the last 10 minutes, average wind speed over the last minute, barometric pressure, relative humidity and this week's rainfall.

The Intermediate report includes all of the Brief report's details and adds this week's rainfall, this month's

rainfall, this year year's rainfall, wind chill and dew point.

The Detailed report includes all of the Brief and Intermediate reports and adds highest and lowest temperature today and times of occurrence, highest and lowest temperature this month and times of occurrence plus the highest and lowest temperature this year and the times of occurrence.

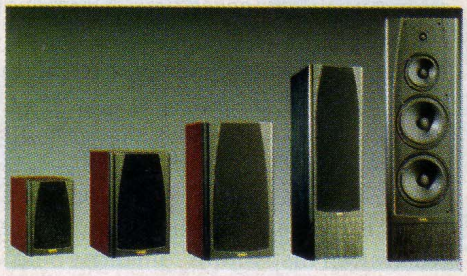
The parameters can be measured in a choice of unit: temperatures can be recorded in Fahrenheit or Celsius; wind speed can be metres/second, knots, km/h or mph; rainfall can be in centimetres, millimetres or inches; barometric pressure can be millimetres or inches of mercury, hectopascals or millibars; and finally, wind direction can be in degrees or Cardinal points.

All of this information is obtained in raw data form from the Ultimeter 2000. It is a compact self-contained unit with a large LCD screen and 16 pushbuttons to display the various readings on the screen. It has inbuilt sensors for temperature and barometric pressure and has external sensors for wind speed and direction, rain gauge, temperature and humidity.

The WeatherVox unit itself is a grey plastic box about the size of a VCR tape housing. It measures 110 x 200 x 30mm. It contains a multi-layer PC board that accommodates all the circuitry. It has been wholly designed and manufactured in Australia. It carries an Austel permit: A95/12/0464.

For more information, contact Sphere Communications, 161 Bunnerong Road, Kingsford, NSW 2032. Phone (02) 9344 9111; fax (02) 9349 5774.

New loudspeakers from Jamo



Jamo has just released a new range of loudspeakers called the "8-Series". This consists of three bookshelf and two freestanding models plus matching centre and surround sound speakers. All have similar styling with a moulded front baffle and they are available in black or mahogany finish. All have a nominal impedance of 6Ω.

The details of the Jamo 8-Series are as follows. The Jamo 28 is a compact bookshelf speaker with a 130mm woofer and a dome tweeter. Its power rating is 55 watts and it is priced at $399 a pair. The Jamo 38 is slightly larger, again with a 130mm woofer and a dome tweeter. It is rated at 60 watts and retails for $499 a pair. The model 68 is the largest bookshelf model with a 165mm woofer and a dome tweeter. Its rating is 80 watts and it retails for $699 a pair.

The model 98 is a 2-way floor-standing speaker with two 165mm woofers and a dome tweeter. Its rating is 90 watts and it retails for $999 a pair.

AUDIO MODULES

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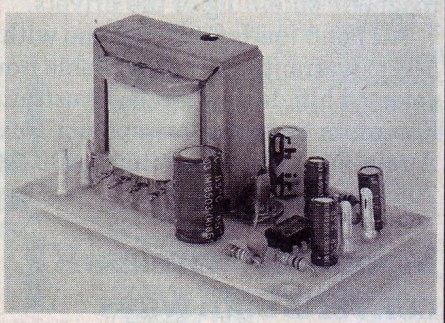

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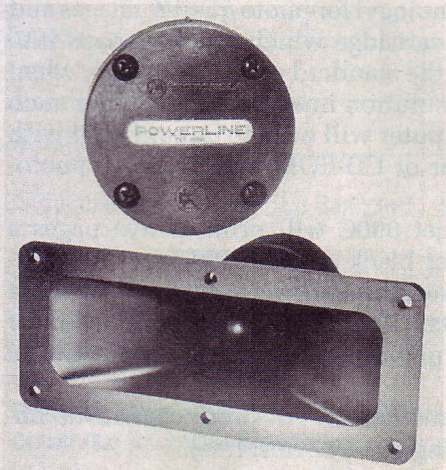

The new Powerline series of Motorola's 2kHz Horn speakers incorporate protection circuitry which allows them to be used safely with amplifiers rated as high as 400 watts. This results in a product that is practically blowout proof. Based upon extensive testing, Motorola is offering a 36 month money back guarantee on this product should it burn out.

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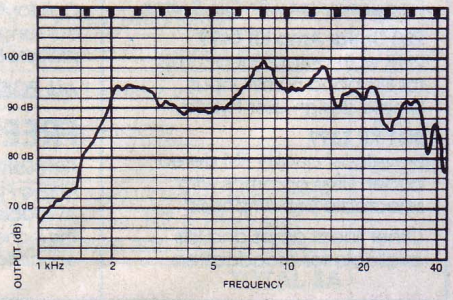
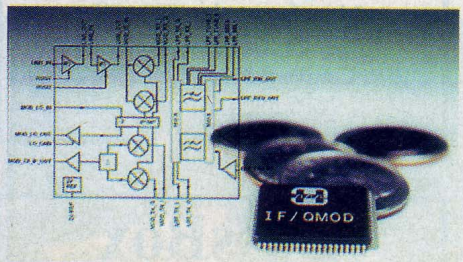
Typical Frequency Response



Finally, the 128 is a large 3-way tower design with two 200mm woofers. It is rated at 140 watts and retails for $1499 a pair. Both floor-standing models have magnetic shielding of the drivers.

All Jamo loudspeakers come with a 5-year warranty and are available from selected hifi dealers around Australia. For more information contact Scan Audio Pty Ltd by phoning 1 800 700 708; fax 03 9429 9309.

Monolithic wireless IC converts both ways



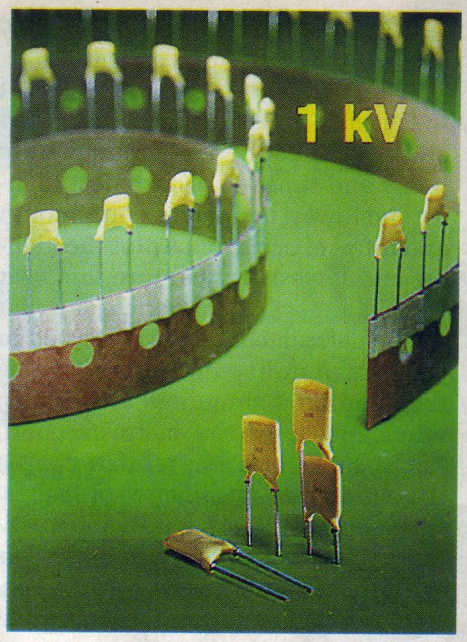
The Harris HFA3724 is the world's first monolithic IF/quadrature modulator/demodulator which converts in both the receive and transmit directions between baseband and intermediate frequencies from 10-40MHz.

The chip simplifies the design of a range of phase-shift (PSK) half-duplex wireless digital communications transceivers. These include wireless local area networks, time-division duplex quadrature modulated communications systems and time-division multiplex access packet protocol radios.

Due to its power management mode, the HFA3724 is suitable for use on PCMIA cards and other portable applications such as wireless handsets. It comes in an 80-lead TQFP package.

For further information, contact the Australian distributor for Harris Semiconductor, BBS Electronics Australia Pty Ltd, Unit 24, 5-7 Anella Ave, Castle Hill, NSW 2154. Phone (02) 9894 5244; fax (02) 9894 5266.

1kV miniature ceramic capacitors



Philips has recently extended its range of miniature ceramic capacitors with the release of a 1kV DC series. These are available in values from 0.47pF to 3300pF with tolerances of ±0.25pF or ±5% for SL types and ±10% or ±20% for class II types.

The operating temperature range is -55°C to +85°C but types with an extended operating temperature of +125°C are also available. These latter types could be used in power supplies, electronic ballasts and automotive applications.

For further information, contact Philips Components, 34 Waterloo Rd, North Ryde, NSW 2213. Phone (02) 9805 4479.

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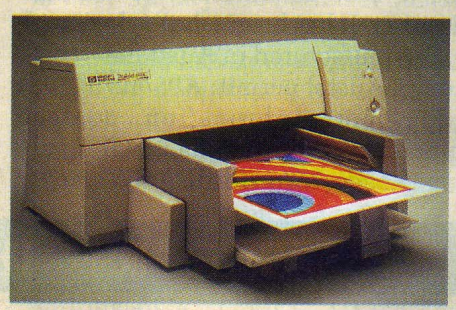
New colour printer from H-P has photo quality



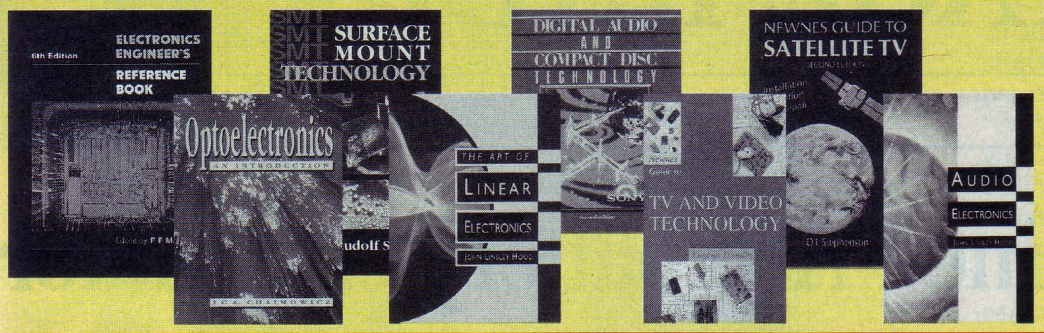
Hewlett Packard has released the HP DeskJet 690C colour inkjet printer for home and office use.

The new printer incorporates HP's Photo REt (Resolution Enhancement technology) for photo quality images and uses a new ink cartridge which quickly snaps into place alongside the standard colour cartridge, when printing high resolution images. Naturally, for such images, the computer will need to be equipped with a colour scanner or CD-ROM drive to read photo-CDs.

The HP Deskjet 690C will print at five pages a minute (PPM) for black and 1.7PPM for colour images. It has a recommended retail price of $654 including sales tax. The HP Photo Colour kit sells for $102 while HP photo paper is priced at $25 for 20 sheets of A4.

Further information on HP products can be obtained by phoning 131 147 (toll free).

Silicon Chip Bookshop



Newnes Guide to Satellite TV

Installation, Reception & Repair. By Derek J. Stephenson. First published 1991, reprinted 1994 (3rd edition).

This is a practical guide on the installation and servicing of satellite television equipment. The coverage of the subject is extensive, without excessive theory or mathematics. 371 pages, in hard cover at $55.95.

Servicing Personal Computers

By Michael Tooley. First published 1985. 4th edition 1994.

Computers are prone to failure from a number of common causes & some that are not so common. This book sets out the principles & practice of computer servicing (including disc drives, printers & monitors), describes some of the latest software diagnostic routines & includes program listings. 387 pages in hard cover at $59.95.

The Art of Linear Electronics

By John Linsley Hood. Published 1993.

This is a practical handbook from one of the world's most prolific audio designers, with many of his designs having been published in English technical magazines over the years. A great many practical circuits are featured – a must for anyone interested in audio design. 336 pages, in paperback at $49.95.

Optoelectronics: An Introduction

By J. C. A. Chaimowicz. First published 1989, reprinted 1992.

This particular field is about to explode and it is most important for engineers and technicians to bring themselves up to date. The subject is comprehensively covered, starting with optics and then moving into all aspects of fibre optic communications. 361 pages, in paperback at $55.95.

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Power Electronics Handbook

Components, Circuits & Applications, by F. F. Mazda. Published 1990.

Previously a neglected field, power electronics has come into its own, particularly in the areas of traction and electric vehicles. F. F. Mazda is an acknowledged authority on the subject and he writes mainly on the many uses of thyristors & Triacs in single and three phase circuits. 417 pages, in soft cover at $59.95.

Guide to TV & Video Technology

By Eugene Trundle. First published 1988. Second edition 1996.

Eugene Trundle has written for many years in *Television* magazine and his latest book is right up date on TV and video technology. 382 pages, in paperback, at $39.95.

Electronics Engineer's Reference Book

Edited by F. F. Mazda. First published 1989. 6th edition.

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This just has to be the best reference book available for electronics engineers. Provides expert coverage of all aspects of electronics in five parts: techniques, physical phenomena, material & components, electronic design, and applications. The sixth edition has been expanded to include chapters on surface mount technology, hardware & software design, semicustom electronics & data communications. 63 chapters, in hard cover at $120.00.

Radio Frequency Transistors

Principles & Practical Applications. By Norm Dye & Helge Granberg. Published 1993.

This book strips away the mysteries of RF circuit design. Written by two Motorola engineers, it looks at RF transistor fundamentals before moving on to specific design examples; eg, amplifiers, oscillators and pulsed power systems. Also included are chapters on filtering, impedance matching & CAD. 235 pages, in hard cover at $85.00.

Surface Mount Technology

By Rudolph Strauss. First published 1994.

This book will provide informative reading for anyone considering the assembly of PC boards with surface mounted devices. Includes chapters on wave soldering, reflow soldering, component placement, cleaning & quality control. 361 pages, in hard cover at $99.00.

Audio Electronics

By John Linsley Hood. Published 1995.

This book is for anyone involved in designing, adapting and using analog and digital audio equipment. Covers tape recording, tuners & radio receivers, preamplifiers, voltage amplifiers, power amplifiers, the compact disc & digital audio, test & measurement, loudspeaker crossover systems and power supplies. 351 pages, in soft cover at $52.95.

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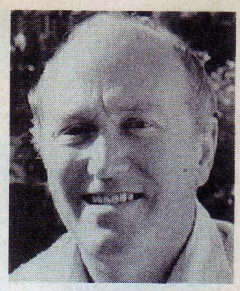


By JOHN HILL

The combined A-B battery eliminator

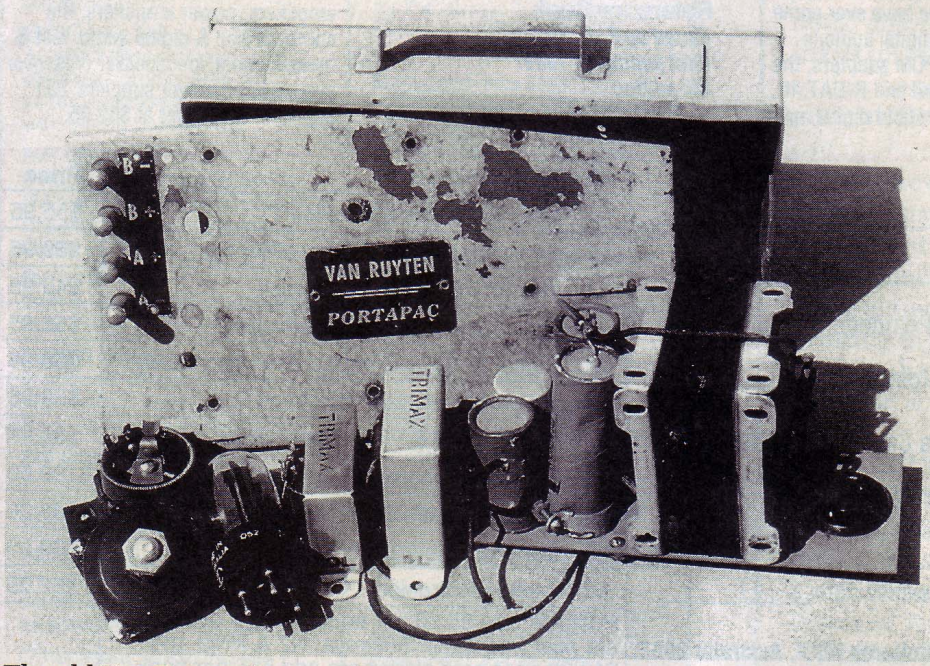
The year 1927 was notable in radio history because it marked a real change in the type of receiver being offered for sale. For the first time, radios that plugged into household power became practical and a number of makes and models were made available.

While there were mains-operated receivers around before 1927, they were few and far between and not many could be described as being really successful. But valves such as the 26, 27, 71A and 80 changed all that and made workable mains-powered radios possible. From that time onward, radio receivers became better and better.

Prior to 1927, almost every radio was battery-powered and the cost of replacing those batteries was a major problem. To help counter this problem, special devices such as "B" battery eliminators and "A" battery trickle chargers were developed. Of course, these money saving accessories were only of use in electrified areas but that included most of the cities and big towns, even back then.

For the benefit of younger readers, it may useful to clarify the terms "A", "B" & "C", as applied to batteries or associated circuits. The term "A" battery was used for the filament battery and, by usage, the filament circuit as a whole. The term "B" battery was used for the high tension battery and its associated circuitry, while the "C" battery was for grid bias circuits.

Of course, battery-powered valve receivers continued in use for a long time after 1927, in some cases until the late 1950s and early 1960s. It took that long for the electricity grid to reach some of the more remote regions of the country.



The old Van Ruyten battery eliminator is shown here stripped, ready for repairs. Like most vintage radio equipment it was in a fairly sorry state.

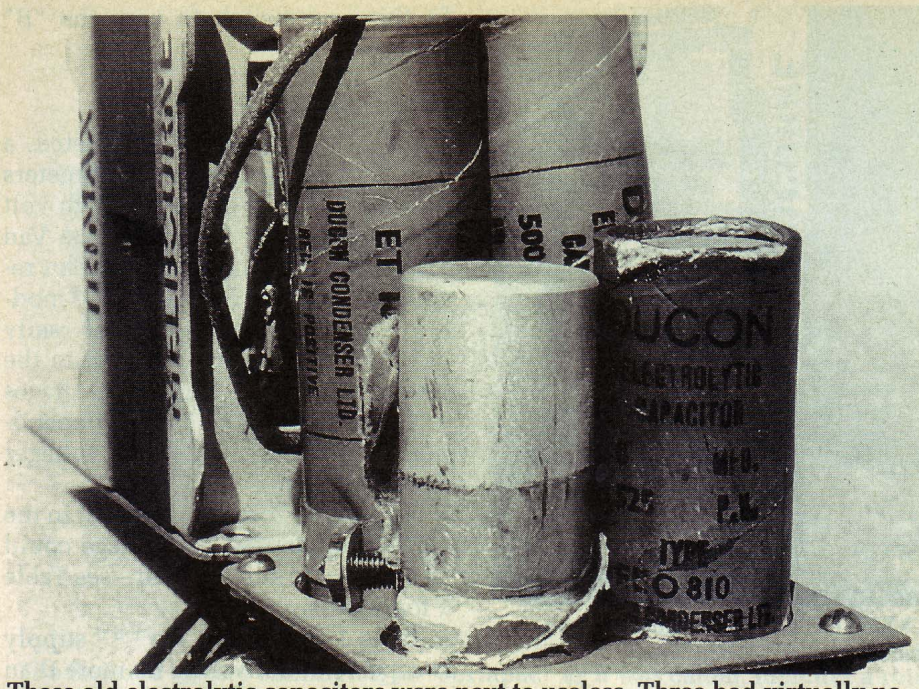
The battery eliminator

Electrification was a mixed blessing for some country folk in that, although their homes had electric power, its arrival meant the obsolescence of some existing household appliances, including the battery radio. In many instances, however, these radios were kept in use by the same device that powered many early battery receivers – the battery eliminator.

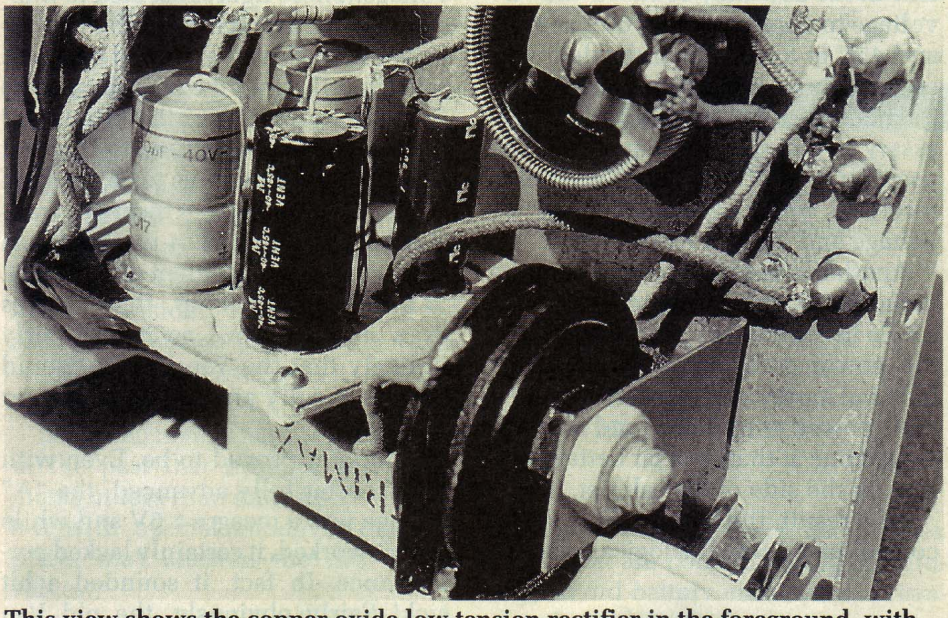
The more modern versions were actually combined "A" and "B" eliminators. This type was never on offer in the 1920s because a satisfactory A battery eliminator was beyond the technology of the day. Such a device required large capacitors and a rectifier capable of passing an amp or more of current. Although such things were available at the time, their large size and high price excluded them from being used in domestic radio applications.

As a result, the rechargeable "A" battery continued in use in combination with a trickle charger. This was the best that could be done at the time. The combined "A-B" battery eliminator of the post-war years solved this problem by using a copper oxide rectifier and large value electrolytic capacitors.

Battery receivers made during this period used low consumption 1.4V



These old electrolytic capacitors were next to useless. Three had virtually no capacitance while the fourth had an internal short.



This view shows the copper oxide low tension rectifier in the foreground, with the replacement electrolytics to the left. The new electros were mounted on a piece of thick cardboard as they were too small to be held by the original clamps.

valves and had considerably reduced low tension requirements compared to receivers from the 1920s and 1930s. A 4-valve set using 1.4V valves consumes only 250mA of filament current. By comparison, a single old 201A valve pulled 250mA at 5V.

An "A" battery eliminator circuit using a transformer (which it shares with the "B" eliminator), a copper oxide rectifier, a choke and a pair of 500µF electrolytics could supply the filament requirements of a late-model battery radio quite easily. Combined "A-B" eliminators kept many battery receivers working without the need to trade-in or modify the receiver for AC operation.

Restoring an eliminator

Battery eliminators are not that common these days but that doesn't mean that they are not worth finding. Any working "A-B" eliminator is a very convenient way to operate a vintage battery radio receiver.

Recently, I was lucky enough to find such a unit, a Van Ruyten, and this month's Vintage Radio will delve into its construction, operation and restoration.

This particular eliminator uses a 5Y3GT valve rectifier for the high tension or "B" voltage supply and a copper oxide rectifier for the filament or "A" voltage supply. Both voltages are well filtered using chokes and electrolytic capacitors. There is also a rheostat to adjust the output voltage of the "A" circuit.

The copper oxide rectifier was an early solid state device and the one in the Van Ruyten is quite small. It provides full wave rectification in conjunction with a centre tapped transformer winding. It was an interesting exercise to check it and compare its performance with a pair of 1A silicon diodes.

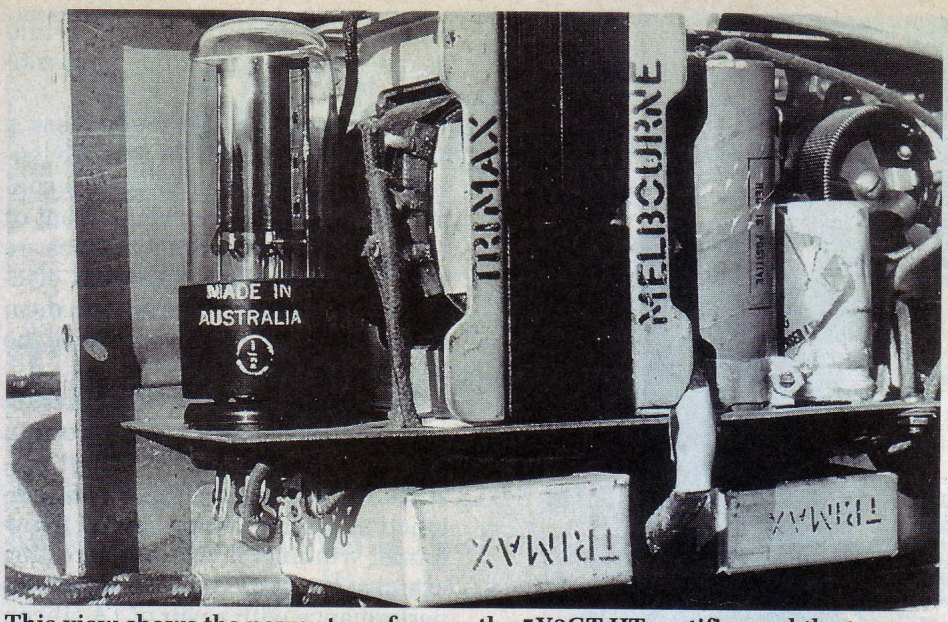
In this particular setup, both rectifiers performed similarly, producing exactly the same voltage under load. And although the silicon diodes, which are quite small, ran warm under test, the copper oxide rectifier remained quite cool.

Because it worked so well, the old rectifier was put back into service so as to keep the unit working with as many of the original components as possible. At least the comparison proved that a couple of silicon power diodes could be used to replace the copper oxide rectifier in this circuit if the need ever arose, without altering the output voltage of the unit.

Output adjustment

Now this old battery eliminator, like most other power supplies of that era, is unregulated in both the "A" and "B" circuits. To counter this problem a 6-ohm rheostat is incorporated into the "A" circuit to help compensate for various loads that may be applied. This allows the correct voltage to be delivered to suit a particular current demand and there is enough adjustment to allow use at 1.4V and 2.0V, although the latter situation is very marginal.

The adjustment procedure for setting the "A" supply is as follows: (1) with the eliminator hooked up to the receiver, connect a voltmeter to the "A" battery terminals of the set; (2) back off the rheostat as far as it will go before switching on; and (3) slowly advance the rheostat until the desired voltage is shown on the voltmeter. And that's it!



This view shows the power transformer, the 5Y3GT HT rectifier and the two Trimax brand filter chokes (beneath the chassis).

The original "B" supply had no adjustment for altering the output voltage but this facility was added during the restoration procedure.

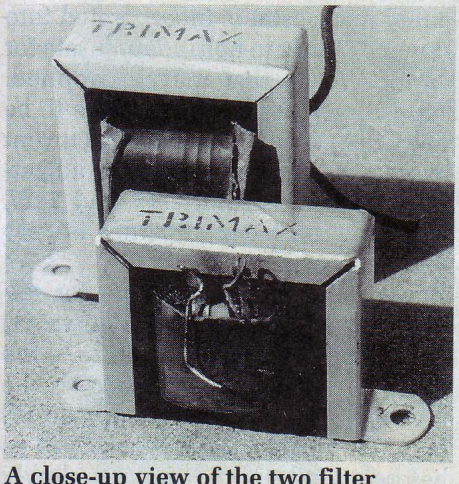
There were a number of other items that needed attention and the old Van Ruyten was completely stripped so as to make the necessary repairs. These repairs included: replacement of the filter capacitors and the 5Y3GT rectifier valve, a new power cord, repainting of the steel cabinet and, as mentioned above, alterations to the high tension circuit to permit the "B" voltage to be varied.

The modification to the "B" circuit involved adding a multi-pole 3-position switch so that two pairs of resistors could be switched into the plate circuits of the high tension rectifier. The resistors used here were 10kΩ and 27kΩ and they reduced the "B" voltage to approximately 60V at 4mA and 45V at 2mA. The unloaded voltage without the resistors is 150V.

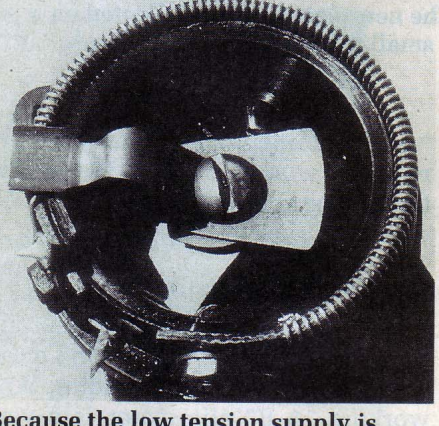
This simple modification was necessary so that the eliminator could be used on 1- and 2-valve regenerative receivers, which have much lower "B" voltage and current requirements.

Another reason for incorporating the variable "B" voltage switch was to fill a hole in the control panel. Originally the power cord exited through this hole but a previous repairer has cut a new power cord hole (and a fairly ragged one at that) in a far better position on the side of the cabinet.

As a result, the leftover hole in the control panel was the logical place to fit the new switch to vary the "B" voltage.



A close-up view of the two filter chokes prior to installation. The larger one at the rear is for the low tension supply.



Because the low tension supply is unregulated, the supply voltage varies with the load. This wirewound rheostat is used to adjust the "A" voltage to suit the receiver.

Performance

With the restoration completed, a couple of wirewound potentiometers were set up in conjunction with volt and amp meters to monitor the Van Ruyten's output capabilities. The results only proved just how good modern regulated power supplies really are compared to something from the Van Ruyten's era. The "B" voltages can vary by as much as 50V, depending on the load, while "A" voltages varied by up to 2.5V.

No wonder there is a rheostat in the "A" circuit so that the voltage could be adjusted to suit the load – see Table 1 for details.

Table 1 shows that the "A" supply is capable of delivering no more than 340mA at 2.0V. Any additional current is obtained at the cost of reduced voltage. These figures seemed to indicate that an average 1930s battery receiver with 2V valves would not work satisfactorily since it would draw more filament current than the eliminator could supply. It was time to find out whether or not this was to be the case.

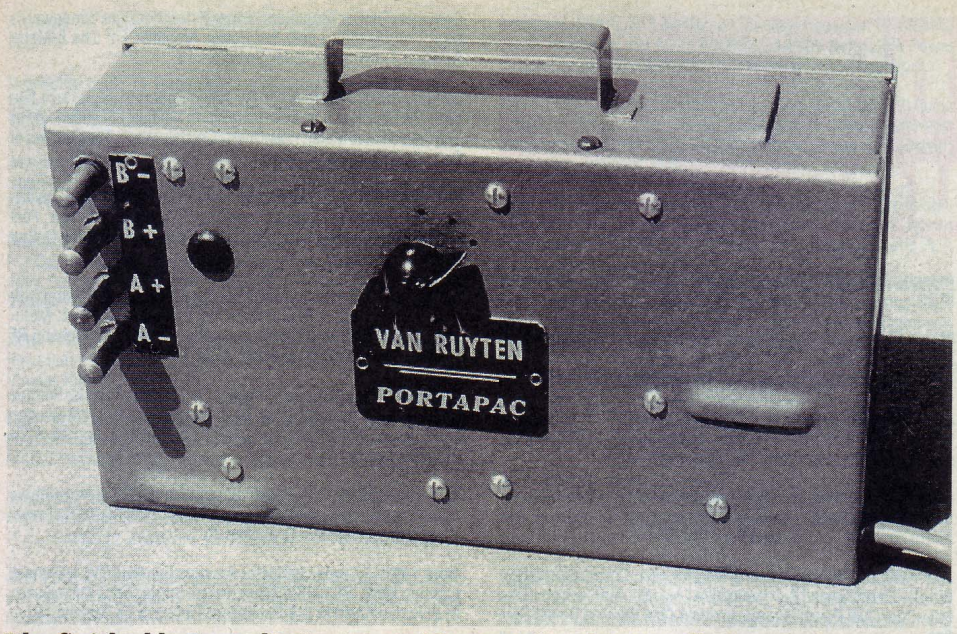
The only 2V battery receiver available for test was a 1937 4-valve Radiola with a valve complement of 1C6, 1D5, 1K6 and 1D4. All up, these valves draw about 540mA so it was fairly unlikely that the Van Ruyten would be able to fully power this particular receiver.

And so it proved to be. Even with the rheostat fully advanced, the "A" voltage was a meagre 1.6V and while the set worked, it certainly lacked performance. In fact, it sounded a bit sick! Fairly obviously, the old Van Ruyten power pack was designed for receivers with 1.4V valves.

Replacing the "A" battery eliminator with a modern 1A regulated power supply showed that the 2V valves would work down to 1.75V. Below that, the performance starts drops off, with the receiver virtually ceasing to function at 1.5V.

Not being the type that gives up easily, I checked all my spare battery valves to see if any were more suitable to the task. Valve filaments are made to tolerances so some must consume less current than others.

Eventually, I selected another set of valves that consumed slightly less current than the originals. This squeez-



The finished battery eliminator, or "Portapac" as it was called, includes a rotary switch on the front panel. This switch serves to fill the hole originally used for the power cord and allows the "B" voltage to be varied in three steps. The rubber grommet near the output terminals allows screwdriver adjustment of the "A" voltage rheostat.

ed the operating voltage up to just over 1.7V and the old receiver fired up much better than before. This was mainly due to a particular 1D4 output valve which had a much more economical filament consumption than the others. That extra tenth of a volt made a considerable difference to the set's performance and another tenth would bring the set up to its full potential.

(Editorial note: it has been suggested in the past that running valve filaments at less than their rated voltage, but with normal anode voltage applied, may shorten the life of the valves.)

Incidently, the "B" voltage drops to around 125V when the old Radiola is working properly. The maximum "B" battery voltage rating for the receiver is 135V.

Eliminator hazards

Unfortunately, using an unregulated "A" supply can have serious repercussions if one of the valve filaments fails. That's because the voltage to the other valves immediately increases because of the reduced load.

In the case of the 1D4 (with its 0.25A filament) failing, approximately 3V would be applied to the other valve filaments. While a minute or so of that sort of treatment probably wouldn't do much harm, it mightn't do 60-year old battery valves much good either. So if you are contemplating rebuilding an old battery eliminator, a regulated supply is the way to go.

Who knows or cares what's inside when the lid is screwed on? However, such an approach is a marked departure from the original circuit and is an unacceptable restoration as far as some collectors are concerned.

Trying out the old Van Ruyten eliminator on a 2-valve battery receiver also proved a disappointment, although the results were expected. What may be an acceptable level of hum in a loudspeaker is not acceptable through headphones. It mattered not whether the "A" or the "B" supply, or both, were used – the hum levels were distracting. Small regenerative receivers using headphones perform best on batteries. **SC**

Table 1

"A" Voltage	Max. Current
1.5V	400mA
2.0V	340mA
4.0V	60mA
"B Voltage"	**Current**
150V	unloaded
120V	10mA
110V	15mA
100V	20mA

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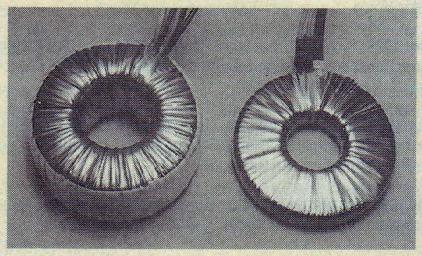
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September 1995: Keypad Combination Lock; The Incredible Vader Voice; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Jacob's Ladder Display; The Audio Lab PC Controlled Test Instrument, Pt.2.

October 1995: Geiger Counter; 3-Way Bass Reflex Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Fast Charger For Nicad Batteries; Digital Speedometer & Fuel Gauge For Cars, Pt.1.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.1; Digital Speedometer & Fuel Gauge For Cars, Pt.2.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.2; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

February 1996: Three Remote Controls To Build; Woofer Stopper Mk.2; 10-Minute Kill Switch For Smoke Detectors; Basic Logic Trainer; Surround Sound Mixer & Decoder, Pt.2; Use your PC As A Reaction Timer.

March 1996: Programmable Electronic Ignition System; Zener Tester For DMMs; Automatic Level Control For PA Systems; 20ms Delay For Surround Sound Decoders; Multi-Channel Radio Control Transmitter; Pt.2; Cathode Ray Oscilloscopes, Pt.1.

April 1996: Cheap Battery Refills For Mobile Telephones; 125W Power Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3; Cathode Ray Oscilloscopes, Pt.2.

May 1996: Upgrading The CPU In Your PC; High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Duplex Intercom Using Fibre Optic Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Installing a Dual Boot Windows System On Your PC; Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-bit Data Logger.

August 1996: Electronics on the Internet; Customising the Windows Desktop; Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: Making Prototype Parts By Laser; VGA Oscilloscope, Pt.3; Infrared Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Feedback On Programmable Ignition (see March 1996); Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; Infrared Stereo Headphone Link, Pt.2; Build A Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

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12V to 6V conversion

It is common practice, when working on old cars, to upgrade the electrical system from 6V to 12V. This is mainly for convenience because 12V batteries and light bulbs are far more readily available than 6V equipment and if your old car is running on 12V you can always use the battery from your modern car to start it.

The bulbs and ignition system can be replaced with 12V types and a 12V dynamo or alternator can be fitted. The car's starter motor can stand the extra voltage under normal use and there's a bonus in that it spins the engine faster, making starting easier.

Where the 6V to 12V conversion starts to get a bit tricky is when you have to deal with items such as fuel gauge senders, fan motors, wiper motors, original radios, solenoids, etc that can't be replaced with 12V equivalents.

One method sometimes adopted is to create a separate 6V source and wire it separately to the equipment that needs it. This can be messy, especially if you need both 12V and 6V feeds through the ignition switch.

My purpose in writing is to ask if SILICON CHIP can design a small cheap 12V to 6V device that can be fitted to the supply wire of each 6V item that has to stay that way. This seems to me to be a fairly neat solution to the problem. If you can come up with such a device, it would be of great help to the old car movement. (R. W., Yeronga, Qld).

• We have published two circuits which could form the basis of a 12V to 6V converter for use in cars. The first is the PCB Drill Speed Controller published in January 1994. This would be good for about one amp or so and is available as a kit from Dick Smith Electronics.

Second, another drill speed controller was published in August 1992 in the Circuit Notebook pages. Provided the output transistor had a suitable heatsink, it could supply several amps. In either case, you would adjust the circuit to deliver about 6.8V, for good performance from 6V accessories.

Solenoid-operated door strike

I have built the magnetic card reader described in the January 1996 issue of SILICON CHIP and I am going to use it as a door lock. I need to know where to obtain a solenoid lock and the cost. And could you please tell me how to wire it up. (D. H., Como West, NSW).

• It should be possible to purchase a solenoid-operated door strike from most locksmiths. Most are powered from 12V (for just short time) and could be operated by the relay on the Magnetic Card Reader. Make sure you purchase a solenoid strike to suit your particular door lock.

Mono output from stereo amplifier

I have a 30W stereo amplifier and wish to run a mono extension loudspeaker. I joined the left and right stereo active signal outputs but this just causes the amplifier to overload and cut out. How can I add a mono speaker to play both channels?

Thanks for your magazine. I have every copy which I cherish. (K. A., Castle Hill, NSW).

• As you have found, you cannot join the active left and right stereo outputs to drive a mono loudspeaker. In effect, this connection would place a short across the two amplifier channels for the difference signal. Your existing left and right speakers would not work in stereo either.

The only way to drive a mono speaker is to mix the left and right channel signals via isolating resistors (say 22kΩ) and then feed the mixed signal to a separate power amplifier which will then drive your mono speaker.

Remote control for outdoor use

I am trying to design and build a remote controller for outside use with a minimum of 10 buttons, all of which must be configurable as toggles or momentary action. I know I could adapt the IR remote train controller circuit of the Railpower design produced by yourselves but my first question is would the IR system be prone to erratic operation if used outside in any kind of weather ranging from hot sunlit days to rainy nights?

I ask this because I realise that the Railpower unit and most IR controllers as used for TV etc are designed for inside use, not outdoors. My next question is that if no problems would arise from using this system in those conditions, then where could I source the ICs. (S. B., Sydney, NSW).

• No infrared system can be expected to work outdoors in daylight. The only effective outdoor remote control will be RF-based, probably UHF, to obtain a small size. You could adapt the Railpower system to UHF, using one the UHF circuits featured in our February 1996 issue. Better still, why not adapt the 8-channel design featured in February 1996 to UHF. It is a relatively simple matter to swap the IR transmitter output stage to a UHF output.

Protecting fragile loudspeakers

My wife has a Mitsubishi hifi unit and up till now, keeps blowing up the speakers. Although a bit of a pain, I have been able to overcome this problem through the local electronic shops being able to supply same or similar. This time she has also put paid to one

of the output power transistors, an NEC D587.

Unfortunately, this has stumped the locals, who don't require a lot of stumping, if I may say so. If you can help me in sourcing a supplier I would be most grateful. The only reason the speakers go is because my other half is getting hard of hearing. A hearing aid would be cheaper but this is a no-go area. Hope you can help. (H. F., Perth, WA).

• We suggest that you consider installing PTC polyswitch thermistors in series with the speakers. These go temporarily open circuit if their current rating is exceeded. We suggest you try installing a type RXE090 or RXE110 PTC thermistor. These are available from Jaycar Electronics in Perth. Phone (09) 328 8252.

As far as the output transistors are concerned, why not contact your local Mitsubishi service agent? They are at 329 Collyer Road, Bassandean WA 6054. Phone (09) 377 3400.

Troubleshooting the Insulation Tester

The Insulation Tester described in the May 1996 issue of SILICON CHIP is a very useful piece of equipment but I have found that the voltages produced are somewhat lower than expected. The 100V, 250V and 500V ranges all produce about 150V. The 600V and 1000V ranges both produce about 450V.

This is an improvement upon the 19V, 148V, 465V, 540V and 290V being produced from the respective (lowest to highest) voltage ranges after first completing the project but still not optimal. I effected this improvement by replacing the CMOS oscillator chip as I had noticed that the CRO traces from the oscillator when the 100V range was selected were almost non-existent. Could the replacement IC be faulty as well or is there a problem with the error amplifier?

Keep those great projects coming. (N. P., Seven Hills, NSW).

• Your problem is possibly due to incorrect transformer windings. Check that the secondary is wound in the same direction as the primary winding as shown in the diagram of Fig.4 (page 35, May 1996). Try winding the secondary in the opposite direction to the way it was.

In addition, check that the range resistors on switch S2b are arranged on your PC board in the correct order.

Dud micro in Dolby decoder

I have recently purchased the Dolby Pro-Logic Surround Decoder, Mk 2, as described in the November & December 1995 issues. My problem is that, upon powering up the unit, the display does not flash "—" at all and the relays do not change state. In addition, the noise LED does not light when the noise sequencer button is pressed.

I have measured the voltages on the power supply module and all are ±5%. I have also measured the voltages on ICs 1-9 as indicated on page 78 of your magazine article (bearing in mind the errata previously advertised).

I have identified that when the unit is powered up, the measured voltage at PC0 is 0V and remains at 0V; ie, it does not go high. Hence Q1 does not switch on to energise the relays. I have removed IC6 and applied 5V to each of the 7-segment LEDs and ascertained that the 7-segment displays are not burnt out but are in good working order. Each of the switches S5, S6 and S7 produce 5V at pins 17, 18 and 19 of IC6 respectively when not pressed and 0V at the same pins when the respective switches are pressed. Pin 2 of IC6 remains at 5V all the time.

I have noted that the voltage signals for "B, A, E, R, S, D" are 5.4V, 1.0V, 2V, 2V, 2V respectively and that they do not change under any condition. I have noticed, though, that IC6 was supplied as an MC68HC705C8ACP, not an MC68HC705C8P. I assume that this is just another variation of the MC68HC705C8P microprocessor chip and is a valid substitute. Could you please help me identify what is the problem with this kit? (C. C., Leeming, WA).

• It appears that the microprocessor (IC6) is either not programmed or faulty. If it is programmed it will be marked accordingly. Either way, the microprocessor should be replaced. The ACP version is slightly different to the P version but we have programmed them to accommodate this difference.

Flatpack transistor washers

I am looking to use the new flatpack MJL21194/21193 transistors as featured in the April 1996 issue but am having trouble finding the isolating mica/silicon washers. The magazine article shows a washer bigger all round than the transistor. Where did you get yours? (R. G., Chapel Hill, Qld).

• You can obtain these washers from Altronics in Perth. They have two types: silicone/fibreglass Cat. H-7220 x 4 or mica type Cat. H-7120 x 4. You can phone Altronics on 1 800 999 007.

Trigger happy laser pistol user

I am writing in regards to the laser pistol and electronic target described in the December 1996 issue of SILICON CHIP. Could you please suggest a way to alter the circuit so that the laser will remain on constantly whenever the trigger is pressed down? It occurred to me to short the 1.5kΩ resistor but I figured this would still create a pulse because of the 100µF capacitor. Your help in this matter would be much appreciated. (J. N., Greenacre, NSW).

• As you suggest, shorting the 1.5kΩ resistor will allow the laser to stay on while ever the trigger is pulled. The 100µF capacitor can then be omitted.

Notes & Errata

MultiMedia Loudspeakers, November 1996: the perspective diagram on page 61 shows the wrong enclosure depth; it should be 224mm.

Control Panel For Multiple Smoke Alarms, January 1997: a 47kΩ resistor should be added to the circuit between pin 11 of IC5f and the +9V rail, while one of the 100µF bypass capacitors on the +9V rail should be 10µF. Note also that the parts list should show four 1kΩ resistors (not three). SC

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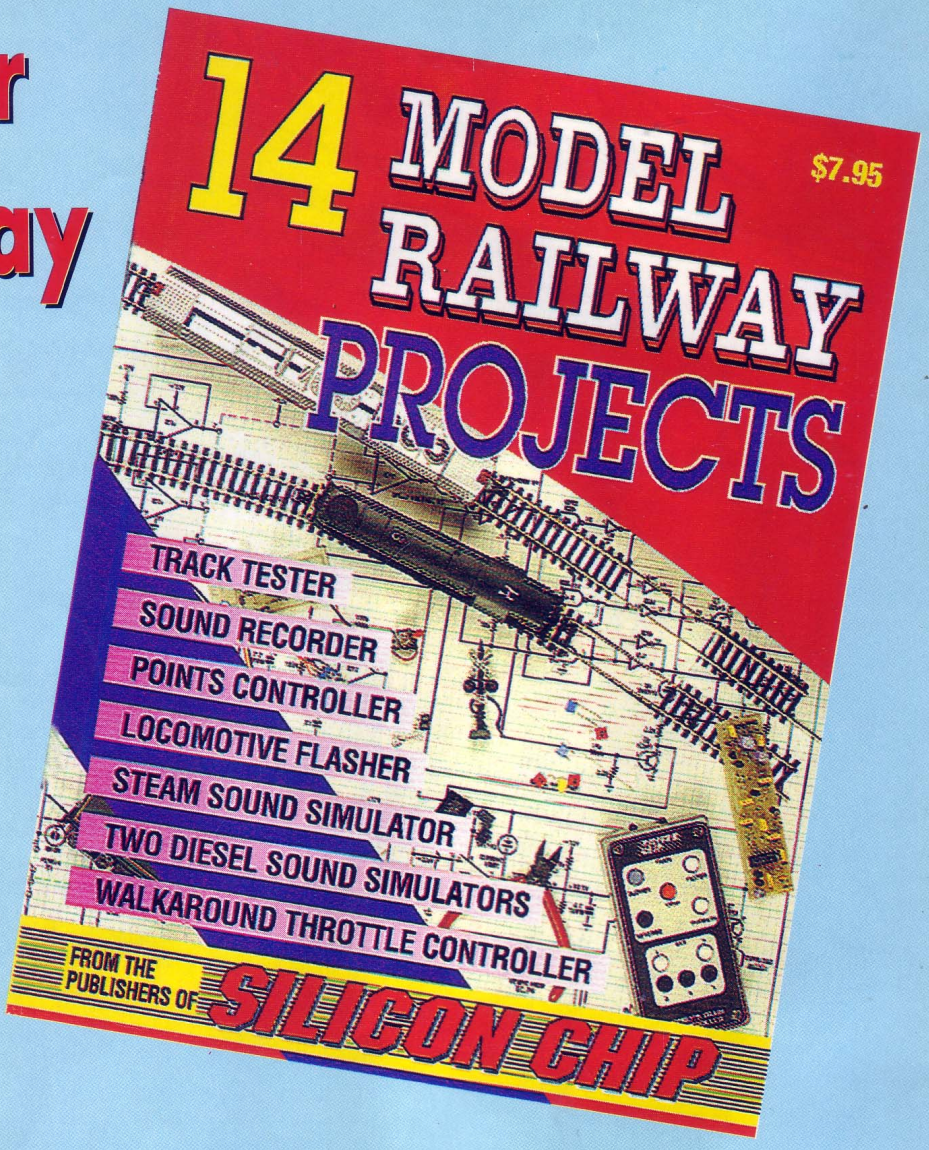

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